# PLEASE

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# LISTINGS

# Introduction to PLEASE

I have been working with minicomputers and microcomputers for nearly eight years. During this time I have seen some pretty horrible examples of how NOT to design small computer software packages. Often, concepts and techniques which might be appropriate to a large computer system are thoughtlessly applied to a small system, with predictably bad results. I have developed a number of programming philosophies and techniques which are designed specifically for the types of small machines that are becoming available to the computer hobbyist and small businessman.

PLEASE is a very small package which embodies several of the more important concepts. It has a tiny monitor which takes care of the basic I/O functions, timing functions, and scheduling. It has a set of functions to perform the major tasks. These functions are combined through the use of a simple interpreter which calls up the functions and passes the necessary parameters to them. Programs are written as a series of functions. Since each function does a major piece of work, a program may consist of only a few functions and can be readily "assembled" by hand. For example, the PLEASE Command Decoder which permits the user to select which game or demo to run from the keyboard is four functions, encoded in a total of 16 bytes.

I am very impressed with the capabilities of the KIM-1 Microcomputer System. Aside from the excruciatingly slow cassette dump/load, it is remarkably well thought out. However, I must admit that after getting my own KIM-1 and doing the single example in the manual I was more than a bit frustrated that there wasn't anything else to do without a great deal of effort on my part. I could only impress my wife and friends slightly by adding 2 + 3 and getting 5! I decided, therefore, to create a small games and demos package that could run on the basic KIM-1, without any additional peripherals such as teletype or special display devices. The result is PLEASE.

PLEASE has been developed entirely on a basic KIM-1. All of the assembly has been done by hand. All of the object code has been entered through the keyboard. Debugging has been via the KIM-1 Monitor. The resulting package demonstrates what can be done on a basic system. It also does suffer in some respects though. Certain changes I would have liked to make became just too much effort via hand assembly.

I welcome any suggestions, comments, or whatever. I have had fun developing PLEASE and hope you will enjoy playing with it.

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The approach that PLEASE uses to create a program is probably quite different from the traditional approaches you have encountered before. Its keywords are simplicity and modularity. Many approaches talk about simplicity and modularity, but by the time you get to really use them they require macro assemblers, linking loaders, compilers, and many other "aids" that often lead to very inefficient code that is very difficult to understand and/or debug. The basic element of PLEASE is the Function. A complex set of tasks can be performed by a fairly limited set of simple tasks, if the correct set of simple functions is selected and if there is a simple way to combine the independent functions into a useful whole. In PLEASE a set of fourteen (14) basic functions has been defined and implemented, and a routine called the Interpreter is used to combine these functions into useful entities called Programs. Certain programs have requirements that are quite unique, and PLEASE provides for special Functions to be written for these. A Program is written in PLEASE as a series of Steps. Each Step consists of the name of a Function and its associated parameters. In a sense, PLEASE programs are written in a form of microcode. Each Step is 32 bits of information: 8 bits of Function name followed by 3 8-bit units of parameter information. A PLEASE Step to get decimal input from the keypad, store the results in consecutive locations starting with a location named Buffer, and display the digits as they are input on the KIM-1 LED's from the leftmost position (Ø) to the rightmost position (5) is:

```
DECIN     BUFFER    Ø         5
```

To have the digits appear in position 5 and then be shifted to the left as in a calculator, the Step would be:

```
DECIN     BUFFER    5         Ø
```

This "microcoding" permits each PLEASE Function to perform in a number of different ways. The richness of the Functions will become apparent in the sections which describe the individual functions.

Before examining the functions in detail, there are a couple of other parts of PLEASE that should be understood. These are the Monitor, the Timer, the Interpreter, and the various memory locations which have been allocated for particular uses.

Monitor. The Monitor performs a number of basic services. It is responsible for maintaining a one millisecond main loop, for accepting in conjunction with the ROM characters from the keypad, for refreshing the LED display, and for branching off to the system Timer and application code. The Monitor is general purpose and can be used entirely independently of the remainder of PLEASE.

Timer. The Timer is based on the one millisecond loop of the Monitor. During each pass through the Monitor, a call is made to the Timer. The Timer updates an eight character timer which can count from 0.001 to 99,999.999 seconds. Every thousand times through the loop, which equals one second, the timer updates a six character clock which counts from

00:00:00 to 23:59:59 as a 24 hour clock. The maintenance of the timer and clock is independent of the remainder of PLEASE, although there are several PLEASE programs which set or display the results of the timer and clock. The contents of the Timer are used by a number of programs to provide pseudo random numbers.

Interpreter. The Interpreter is the heart of the PLEASE technique, but is itself very simple. It has three basic purposes. First, it converts the Step Number to be executed into an absolute memory address and then bumps the Step Number to the next Step, just as a Program Counter does. Second, it moves the four bytes which consist of the Function Code and the three Parameter bytes from their original location to a standard location in the Page Zero making them easily accessible to the Functions. Finally, it looks up the address of the Function via the Function Code and the Function Table, and then transfers control to the Function. In this way the independent PLEASE Functions are tied together into a meaningful whole.

Memory Locations. PLEASE has very carefully partitioned the limited KIM-1 memory. The Monitor, which never changes, is always resident, and which may be used without the rest of PLEASE, is placed "out-of-the-way" in the extra RAM locations of the 6530 chips. These locations start at 1780 and go to 17E6. The remaining RAM locations 17E7 through 17FF are used by the KIM-1 Monitor. The Timer starts at location 200, the Interpreter at 300. The remainder of the locations in 200 through 3FF are used for the fourteen basic PLEASE Functions and some subroutines which are used by the Functions. This section of memory is also never modified by the basic PLEASE programs. Page One contains the Function Table in 100 through 11F, Special Function Table in 120 through 12F, Special Functions in 130 through 1EF, and the Stack in 1F0 through 1FF. The PLEASE Programs start at location 00. Page Zero is used for many purposes as described later. The memory ordering has been made to be least volatile in high memory, most volatile in low memory. Overlays always start at location 00.

Functions. The fourteen basic PLEASE Functions may be broken down into a few categories:

Input. The only PLEASE Input device is the KIM-1 Keypad. There are three input modes: Alphabetic, Hexidecimal, and Decimal.

Output. The only PLEASE Output device is the KIM-1 Display. There are three output modes: Alphabetic, Hexidecimal, and Decimal.

Time. A timer routine provides for delays of up to 25 seconds in one-tenth of a second increments.

Pack. A pair of functions provide for data to be packed as two characters per byte or to be unpacked into separate bytes.

Branch. There are three basic forms of branch: unconditional, and conditional on an input character or conditional on a table lookup value.

Fill. There is a function to fill/clear memory locations.

Match. There are two functions which permit comparing strings of data and branching on the result.

Special Functions. The basic fourteen PLEASE Functions can not, of course, do everything. Special Functions may be added whenever the basic functions either could not do the job, or would be too inefficient. Examples of Special Functions include: MASTER - the evaluator for the Daffy (Mastermind) Game; MESAGE - the heart of the Notice and Billboard Programs; and, START and SHOT - initializer and evaluator for Shooting Stars.

Programs. The current PLEASE package consists of about fifteen programs. These vary in complexity and size. SCLOCK (set clock) is only two basic PLEASE Functions. HiLo (Number Guessing Game) is nineteen basic PLEASE Functions. Daffy (Mastermind Game) is thirteen basic Functions and one special Function. And so forth.

Subroutines. There are about six subroutines in PLEASE. These are an odd collection of chunks of code that were useful to have around and were shared by one or more independent functions, but which were not powerful enough to warrant being treated as Functions.

The only way to understand PLEASE is to use it. Write your own programs entirely in PLEASE Functions. When a special need arises, write your own Special Function. Have fun. Enjoy.

NOTE: A word of Caution. Since this was all done by hand, it is quite possible that there may be one or more errors in the typing of the Programs and/or Source Listings. All code on the cassette was entered from the listings, so that the Object of the listings is probably okay. If you see a discrepancy between the Object and the Operation, the Object is probably right and the Operation wrong.

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

The KIM-1 is made by MOS TECHNOLOGY, INC. Its list price as of December 1976 is $245.00 + 4.50 postage and handling. This is a fully assembled and tested unit and includes three manuals: KIM-1 User Manual, Programming Manual and Hardware Manual. You must provide your own power supply which has +5vdc @ 1.2 amps and +12vdc @ .2 amps. Other modules available from the same source are KIM-2 a 4K RAM, KIM-3 an 8K RAM, a mother board, and several ROM programs including a KIMath math package and an Editor/Assembler. Address is: 950 Rittenhouse Road, Norristown PA 19401
Phone: 215/666-7950

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

IMPORTANT NOTICE: If you did not purchase your copy of PLEASE directly from The COMPUTERIST, then please send us your Name, Address, and Cassette Tape Number. This will enable us to keep you informed of any updates, new products, or corrections that occur in the future.
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EXINIT initializes the pointer to the first application subroutine and initializes the location CHAR to indicate no valid input character has been received.

```
1780  A9  00      EXINIT  LDA  #DCDLO     DCDLO = Application Low
1782  8D  CC  17          STA  EXAPLO     Address to Exec Transfer
1785  A9  03              LDA  #DCDHI     DCDHI = Application High
1787  8D  CD  17          STA  EXAPHI     Address to Exec Transfer
178A  A9  20              LDA  #20        20 is used to indicate
178C  85  DB              STA  CHAR       NO character input
```

EXLOOP controls a one millisecond loop which is required to permit the Display to be properly refreshed. KEYIN uses the KIM-1 ROM routines to input a character from the Keypad, and then performs "debouncing" of the Keypad. DSPLAY causes the next character in a six character Page Zero buffer to be displayed on the LED Display for one millisecond. Other routines are accessed via subroutine calls. TIMER updates a series of counters which provide decimal count from 1 millisecond up to 99,999.999 seconds. It also maintains a 24 hour clock, providing hours, minutes and seconds.

```
178E  A9  7B      EXLOOP  LDA  #7B        Set Millisecond Timer
1790  8D  45  17          STA  1745       (Actually 984 microseconds)

1793  20  88  1E  KEYIN   JSR  INITS      Setup for Keyboard Input
1796  20  6A  1F          JSR  GETKEY     Get Keyboard Input if any
1799  C9  14              CMP  #KEYMAX    Was there a Key Pressed ?
179B  30  04              BMI  KEYIN2     Yes, a Key was Pressed
179D  85  DE              STA  KEYTST     No, so reset debounce flag
179F  D0  0A              BNE  DSPLAY     Unconditional Branch
17A1  A6  DE      KEYIN2  LDX  KEYTST     Test debounce flag.
17A3  F0  06              BEQ  DSPLAY     Branch if not a new char.
17A5  85  DB              STA  CHAR       Save new character
17A7  A9  00              LDA  #00        Clear debounce flag
17A9  85  DE              STA  KEYTST

17AB  A4  D9      DSPLAY  LDY  DSPPOS     Current Display Pointer
17AD  98                  TYA             Calculate Select Line
17AE  0A                  ASL
17AF  69  08              ADC  #8
17B1  8D  42  17          STA  1742       Select Display Position
17B4  A9  7F              LDA  #7F        Select All Output Lines
17B6  8D  41  17          STA  1741
17B9  B1  CE              LDA  (DSPLO),Y  Get Display Character from
17BB  8D  40  17          STA  1740       Display Buffer and Output
17BE  88                  DEY             Decrement Position Pointer
17BF  10  02              BPL  DSPLY2     Okay if Positive
17C1  A0  05              LDY  #5         Else, Reset to Maximum
17C3  84  D9      DSPLY2  STY  DSPPOS     Save Pointer for Next Loop
```

Other routines are now invoked via subroutine jumps. TIMER is an optional routine. The next slot is available for any other routine that is to be included in every EXLOOP. Currently it is not being used and is therefore replaced by three NOPs. The actual application that is being run is accessed via the JSR APPL where the address of the application routine has been filled in at run time. It is initially set to address 0300 by the EXINIT code. It can be simply changed by the application by use of the EXSET routine explained below.

```
17C5  20  00  02          JSR  TIMER        Go to TIMER subroutine
17C8  EA  EA  EA        (JSR  ?????)        NOPs can be changed
17CB  20  00  03          JSR  APPL         This goes off to Application
```

EXWAIT waits for the interval timer to finish its 992 microsecond count. It then restarts the EXLOOP for the next millisecond loop. The testing and restart takes approximately 16 microseconds bringing the total time up to approximately 1000 microseconds or one millisecond.

```
17CE  2C  45  17  EXWAIT  BIT  1745        Test Current Interval
17D1  10  FB              BPL  EXWAIT      Not done if Positive
17D3  30  B9              BMI  EXLOOP      Done if Negative
```

EXSET is provided to make it easy for an application to change the location to be accessed on the next application call via the JSR APPL. The application code places a JSR EXSET immediately in front of the instruction which is to start the next application processing. EXSET picks up this address and places it into the JSR APPL instruction and then returns to EXWAIT by making a subroutine return RTS.

```
17D9  68            EXSET  PLA               Pull Address of Next
17DA  8D  CC  17           STA  EXAPLO        Application Instruction
17DD  EE  CC  17           INC  EXAPLO        and Save and Correct
17E0  68                   PLA               Pull Page Address of Next
17E1  8D  CD  17           STA  EXAPHI        Appl. Inst and Save it.
17E4  60                   RTS               Return to EXLOOP at EXWAIT
```

EXAMPLE: Within an application there is a need to wait for 10 milliseconds. After JSR EXSET pointers set to call HERE on next JSR APPL.

```
                .
                .
                LDA  #10.          Set Counter = 10.
                STA  COUNT
WAIT            JSR  EXSET         Return to EXLOOP with
HERE            DEC  COUNT         HERE as NEXT ADDRESS
                BNE  WAIT          Keep Waiting Until BEQ
                .
                .
```

On each pass through the PLEASE Monitor EXLOOP, a one millisecond loop, a subroutine call is made to a TIMER subroutine. This routine provides two services. First, it updates an eight character millisecond based counter which has a range of 0.0 to 99,999.999 seconds and which is used by many programs to generate pseudo random numbers, is used by the reaction time program to calculate reaction time, and so forth. Second, it updates a six character 24 hour clock to provide time in hours, minutes and seconds. This subroutine is written to be relocatable anywhere in memory. For PLEASE, it is assembled at location 200. The eight character timer data is stored in four bytes starting at location CØ. The six character clock data is stored in three bytes starting at location C4. Location C7 is used as a counter.

```
200  F8       TIMER   SED             Calculations done in Decimal Mode
201  A2 03            LDX  #3         Setup Counter for Timer

203  18       TIMER1  CLC             Clear Carry Bit
204  B5 C0            LDA  THOUS,X    Add 1 to Current Timer Value
206  69 01            ADC  #1
208  95 C0            STA  THOUS,X
20A  90 2D            BCC  TDONE      All done if no Carry

20C  E0 03            CPX  #3         Test Carry from Millisecond
20E  D0 26            BNE  TIMER2     Skip Clock Update unless Millisecond
210  C6 C7            DEC  ONESEC     Decrement a Ten * 1/10 second counter
212  D0 22            BNE  TIMER2     Skip Clock Update unless 10 counts
```

If one second has expired since the last update of the Clock, then the Clock is updated. First the seconds byte is incremented and tested for its limit (60 seconds). If not equal to its limit a test is performed to test the hour byte limit. If the hour byte is not equal to its limit (24 hours), then the clock portion of the Timer subroutine is complete. If the seconds byte is equal to its limit, then it is reset to zero and the minutes byte is incremented. It is tested in exactly the same manner (actually the same code) as the seconds for its limit. After the seconds, minutes, and hours bytes have been updated, the Ten * 1/10 second counter is reset and the X index register is reset.

```
214  18       CLOCK   CLC
215  B5 C3            LDA  MILLI,X    Get Byte Using Index
217  69 01            ADC  #1         Increment Byte
219  C9 60            CMP  #60        Test Second or Minute Limit
21B  D0 07            BNE  HTEST      Not Limit.  Test Hour Limit
21D  A9 00            LDA  #0         Reset Second or Minute to Zero
21F  95 C3            STA  MILLI,X    Save Modified Byte
221  CA               DEX             Decrement Index
222  10 F0            BPL  CLOCK      Unconditional Branch
```

```
224  E0 01    HTEST   CPX  #1         Is this the Hour Byte?
226  D0 06            BNE  CDONE      If not, then Clock is Done
228  C9 24            CMP  #24        Test Hour Limit
22A  D0 02            BNE  CDONE      If not Limit, then Clock is Done
22C  A9 00            LDA  #0         If Limit, Reset to Zero

22E  95 C3    CDONE   STA  MILLI,X    Store Modified Value
230  A2 03            LDX  #3         Restore Index Value
232  A9 0A            LDA  #A         Reset Ten * 1/10 Counter
234  85 C7            STA  ONESEC

236  CA       TIMER2  DEX              Decrement Index
237  10 CA            BPL  TIMER1     If Index Positive, Continue Updates

239  D8       TDONE   CLD              All Done.  Clear Decimal Mode
23A  60              RTS              Subroutine Return
```

These updated Timer and Clock values are now ready to be used for the various purposes of PLEASE and can be displayed on the six character display.

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

Alpha Display Table

| Loc | Value | Key | Character |
|---|---|---|---|
| 3F0 | 77 | Ø | A |
| 3F1 | 7C | 1 | b |
| 3F2 | 58 | 2 | c |
| 3F3 | 5E | 3 | d |
| 3F4 | 79 | 4 | E |
| 3F5 | 71 | 5 | F |
| 3F6 | 76 | 6 | H |
| 3F7 | 30 | 7 | I |
| 3F8 | 38 | 8 | L |
| 3F9 | 54 | 9 | n |
| 3FA | 5C | A | o |
| 3FB | 73 | B | P |
| 3FC | 50 | C | r |
| 3FD | 6D | D | S |
| 3FE | 78 | E | t |
| 3FF | 6E | F | Y |

Hexidecimal Display Table

| Loc | Value | Key | Character |
|---|---|---|---|
| 1FE7 | 3F | Ø | Ø |
| 1FE8 | 06 | 1 | 1 |
| 1FE9 | 5B | 2 | 2 |
| 1FEA | 4F | 3 | 3 |
| 1FEB | 66 | 4 | 4 |
| 1FEC | 6D | 5 | 5 |
| 1FED | 7D | 6 | 6 |
| 1FEE | 07 | 7 | 7 |
| 1FEF | 7F | 8 | 8 |
| 1FF0 | 6F | 9 | 9 |
| 1FF1 | 77 | A | A |
| 1FF2 | 7C | B | b |
| 1FF3 | 39 | C | C |
| 1FF4 | 5E | D | d |
| 1FF5 | 79 | E | E |
| 1FF6 | 71 | F | F |

Note: The Hexidecimal Display Table is located in the KIM-1 ROM. The table actually has bit 80 on in each byte, that is location 1FE7 actually contains a BF which is 3F + 80. Only those bits which have associated display segments are listed in this table.

A program written in PLEASE consists of a series of Functions and their associated Parameters. It is the responsibility of the Interpreter to: maintain a pointer to the next Step to be executed; convert the Step Number to the actual Step Location in memory; move the Function Code and the Parameter Values to standard Page Zero locations; lookup the actual memory address of the Function in the Function Table; and, transfer control to the selected Function. The Interpreter is the "glue" that holds the independent Functions together to form a Program.

A portion of the Monitor initialization sequence invoked when the system is started at location 1780 sets up a pointer in the Monitor so that the first call to the Application code comes to the Interpreter at location DECODE. This causes the Step Number STEPNO to be set to zero. This will cause the PLEASE Function at STEPNO Ø or Location ØØØØ to be the first Function executed. In all of the current PLEASE programs this is the start of the Command Decoder which occupies four Steps. If a PLEASE module is written which only contains a single program and therefore does not require a Command Decoder, then the first Function could be the start of the program itself. The entry point SETSTP is used to permit certain Functions to change the order of execution, that is cause a branch, by entering with the new next step value in the Accumulator. The entry point NXTSTP is the normal entry point where no modification of the Step Number is required. The subroutine jump to EXSET guarantees that the Monitor will gain control at least once during each Step, permitting the Keyboard to be tested for input, the Display to be refreshed, and the System Clock and Timer to be updated. On return from EXSET the Step Number is converted into the actual Step Location in memory. Valid Step Numbers range from ØØ to 27 and address locations ØØØØ to ØØ9C.

```
300  A9 00     DECODE  LDA  #00
302  85 B7     SETSTP  STA  STEPNO
304  20 D9 17  NXTSTP  JSR  EXSET
307  A5 B7             LDA  STEPNO
309  0A                ASL
30A  0A                ASL
30B  85 B8             STA  STEPLO
```

STEPLO now points to the first byte of the four byte Step. These four bytes are transferred to standard locations in Page Zero. The data is moved in reverse order: PARAM3, PARAM2, PARAM1, and PARAMØ. STEPNO is incremented in preparation for the next step.

```
30D  A0 03            LDY  #3
30F  B1 B8     PARMOV LDA  (STEPLO),Y
311  99 B0 00         STA  PARAMO,Y
314  88               DEY
315  10 F8            BPL  PARMOV
317  E6 B7            INC  STEPNO
```

The Function Code and the three Parameters have now been moved to the standard Page Zero locations where they are readily available to the specific Functions. The Function Code itself is still in the Accumulator and is now multiplied by two via the ASL command to be used as an index into the Function Table which contains the two byte memory address of each Function. The Function Code * 2 which is in the A register now, becomes the low address for the Function Table lookup, and is stored in location 320 where it becomes part of an Indirect Jump instruction. The location BREAK contains the first of two consecutive NOP instructions. Normally this code will be executed with no effect on the process. The NOP at BREAK may be changed into a BRK instruction for debugging purposes. To use the BREAK, you must first set up a transfer vector to the KIM Monitor at locations 17FE and 17FF: 17FE 00 and 17FF 1C. Then you can change the NOP at 31D to a BRK: 031D 00. Now when you execute PLEASE, starting at 1780 as usual, you will be "trapped" back to the KIM Monitor. The display will show 031F 6C which is the first byte of the Indirect Jump instruction at location 031F. You may now examine and/or modify any memory locations, registers, and so forth using the KIM Monitor commands. When you are ready to execute the current PLEASE Function, press PC to restore the pointer to 031F and then GO to run the program. You may also put the machine into single step mode at this point by setting the transfer vector at 17FA to 00 and 17FB to 1C. Then put the Single Step switch into single step mode. Then pressing GO will cause a single step to execute. In this way you can step through any Function.

```
319  0A               ASL
31A  8D 20 03         STA  0320
31D  EA        BREAK  NOP
31E  EA               NOP
31F  6C 00 01         JMP  (FUNCTION NUMBER * 2, 01)
```

The PLEASE Function Table starts at location 0100. Since each Function requires two bytes of address, locations 0100 through 011F are used for the standard PLEASE Functions. Locations 0120 through 012F are reserved for any future expansion of PLEASE or for special Functions which are required by some of the programs.

Every Function returns to the Interpreter when finished with its operation. Some return via the SETSTP location when they are modifying the order of Step execution, that is are causing a branch. Most Functions return via the NXTSTP location which causes the next Step in sequence to be executed.

| | | |
|---|---|---|
| B0 | PARAMØ | Parameter Ø is usually the COMMAND CODE |
| B1 | PARAM1 | Parameter 1 is usually DATA |
| B2 | PARAM2 | Parameter 2 is usually DATA |
| B3 | PARAM3 | Parameter 3 is usually DATA |
| B4 | ADRLO | Low Address pointer for Indirect Address |
| B5 | ADRHI | High Address pointer for Indirect Address |
| B6 | PNTR | Temporary Pointer Storage |
| B7 | STEPNO | Number of NEXT PLEASE Step |
| B8 | STEPLO | Low Address of Current PLEASE Step |
| B9 | STEPHI | High Address of Current PLEASE Step |
| BA | TRANLO | Temporary Transfer Pointer to PLEASE Function |
| BB | TRANHI | Temporary Transfer Pointer to PLEASE Function |
| BC | FUNTBL | Low Address of PLEASE Function Table |
| BD | FUNTBH | High Address of PLEASE Function Table |
| BE | PTEMPØ | PLEASE Temporary Storage |
| BF | PTEMP1 | PLEASE Temporary Storage |
| | | |
| C0 | THOUS | Thousands and Tens of Thousands of Seconds |
| C1 | TENS | Tens and Hundreds of Seconds |
| C2 | TENTHS | Tenths and Seconds |
| C3 | MILLI | Thousandths and Hundredths of Seconds |
| C4 | HOUR | Hour portion of 24 Hour Clock |
| C5 | MINUTE | Minute portion of 24 Hour Clock |
| C6 | SECOND | Second portion of 24 Hour Clock |
| C7 | ONESEC | Counter for One Second |
| | | |
| C8 | DSPØ | Display Position Ø (Leftmost Digit) |
| C9 | DSP1 | Display Position 1 |
| CA | DSP2 | Display Position 2 |
| CB | DSP3 | Display Position 3 |
| CC | DSP4 | Display Position 4 |
| CD | DSP5 | Display Position 5 (Rightmost Digit) |
| CE | DSPLO | Low Address of Display Buffer (Usually = DSPØ = C8) |
| CF | DSPHI | High Address of Display Buffer (Usually = DSPØ = 00) |
| | | |
| D0 | DCONLO | Display Conversion Table Low Address |
| D1 | DCONHI | Display Conversion Table High Address |
| D2 | HEXLO | Hexidecimal (and Decimal) Conversion Table Low Address = E7 |
| D3 | HEXHI | Hexidecimal (and Decimal) Conversion Table High Address = 17 |
| D4 | ALPHLO | Alphabetic Conversion Table Low Address (usually = FØ) |
| D5 | ALPHHI | Alphabetic Conversion Table High Address (usually = 03) |
| D6 | XTABLE | Used by Conversion Routine to Point to HEX or ALPHA Table |
| D7 | TEMP | General Purpose Temporary Save Location |
| D8 | LIMIT | Used by Conversion Routine. General Purpose Register |
| D9 | DSPPOS | Executive Pointer to Current Display Position |
| DA | CURPNT | Used by Input Routines as Current Data Pointer. |
| DB | CHAR | Save Location for Input Character |
| DC | CTABLO | Command Table Low Address (usually = AØ) |
| DD | CTABHI | Command Table High Address (usually = ØØ) |
| DE | KEYTST | Used by Executive as part of Keyboard Input |
| DF | KEYVAL | Contains Last Character of Input String |

| | | |
|---|---|---|
| E0 | BUFØ | General Purpose Buffer |
| E1 | BUF1 | |
| E2 | BUF2 | |
| E3 | BUF3 | |
| E4 | BUF4 | |
| E5 | BUF5 | |
| E6 | ALTØ | Alternate General Purpose Buffer |
| E7 | ALT1 | |
| E8 | ALT2 | |
| E9 | ALT3 | |
| EA | ALT4 | |
| EB | ALT5 | |
| EC | APLØ | Application General Registers |
| ED | APL1 | |
| EE | APL2 | |

Other PAGE ZERO Location Information

| | |
|---|---|
| 00 to 9F | PLEASE CODE, four bytes per STEP, max 40. (28) Steps. |
| 00 to 0F | PLEASE CODE for COMMAND DECODER |
| A0 to AF | COMMAND TABLE contains two bytes per entry, max eight (8) Commands |
| EF to FF | Used by KIM-1 Monitor |

| | | |
|---|---|---|
| EF | PCL | Program Counter - Low Order Byte |
| F0 | PCH | Program Counter - High Order Byte |
| F1 | P | Status Register |
| F2 | SP | Stack Pointer |
| F3 | A | Accumulator |
| F4 | Y | Y-Index Register |
| F5 | X | X-Index Register |

Other MEMORY Location Information

| | |
|---|---|
| 100 to 11F | PLEASE Function Table, two bytes per entry, Low-High Address |
| 120 to 12F | APPLICATION Specific Function Table |
| 130 to 1EF | APPLICATION Specific Assembly Level Code |
| 1F0 to 1FF | STACK |
| 200 to 3FF | Standard PLEASE Functions Assembly Level Code |
| 1780 to 17E6 | PLEASE Executive |
| 17E7 to 17FF | Used by KIM-1 Monitor |
| 1800 to 1FFF | KIM-1 Monitor (ROM) |

Code: ØØ

Function: ALPIN

Purpose: Accept Alphabetic Input from the Keypad, store it in memory, convert to displayable characters, and display characters as input.

Command: ALPIN
Param1: Memory Address to Store Characters. Page Zero Locations.
Param2: Start Display Location. Leftmost = Ø, Rightmost = 5.
Param3: End Display Location. Leftmost = Ø, Rightmost = 5.

Param2 and Param3 control how many characters may be input - 1 to 6, where the characters get displayed within the six digit LED, and the mode of displaying - either fillin or shift. The number of characters equals the absolute difference between Param2 and Param3 plus 1. Where they are displayed is determined by Param2, the Start Display Location. The mode of displaying is fillin if the Start Location is less than the End Location. The mode of displaying is shift if the Start Location is greater than the End Location. If equal the mode is fillin.

The input data is stored as one character per byte in consecutive memory locations in Page Zero starting at the location specified by Param1. The order of storing is independent of the display mode. The first character typed is stored in the specified memory location, the second character in the next location,.... See page 9 for the Keypad to Alpha Conversions.

Function: HEXIN Code: Ø1

Purpose: Accept Hexidecimal Input from the Keypad, store it in memory, convert to displayable characters, and display characters as they are input.

Command: HEXIN
Param1: Memory Address to Store Characters. Page Zero Locations.
Param2: Start Display Location. Leftmost = Ø, Rightmost = 5.
Param3: End Display Location. Leftmost = Ø, Rightmost = 5.

See ALPIN above for details on operation and parameters.

Function: DECIN Code: Ø2

Purpose: Accept Decimal Input from the Keypad, store it in memory, convert to displayable characters, and display characters as they are input.

Command: DECIN
Param1: Memory Address to Store Characters. Page Zero Locations.
Param2: Start Display Location. Leftmost = Ø, Rightmost = 5.
Param3: End Display Location. Leftmost = Ø, Rightmost = 5.

See ALPIN above for details on operation and parameters.

ALPIN, HEXIN, and DECIN use the same source code. The only difference is in the conversion tables used and the input limits set. These differences are taken care of by short initialization sequences as follows.

ALPIN uses the entry point ALPHA. It sets up a pointer to the Alpha Table and sets the input limit to 1Ø which permits input in the range Ø to F.

```
329  A9 10     ALPHA   LDA  #10
32B  A2 D4                LDX  #ALPHLO
32D  D0 08                BNE  SETTAB
```

HEXIN uses the entry point HEXIN. It sets up a pointer to the Hexidecimal Table and sets the input limit to 1Ø which permits input in the range Ø to F.

```
32F  A9 10     HEXIN   LDA  #10
331  D0 02             BNE  SETHEX
```

DECIN uses the entry point DECIN. It sets up a pointer to the Hexidecimal Table and sets the input limit to 1Ø. which permits input in the range Ø to 9. A call is then made to the subroutine DIRADR which converts the Paraml address into a two byte address which is stored in a pair of Page Zero locations ADRLO and ADRHI for general usage.

```
333  A9 0A     DECIN   LDA  #0A
335  A2 D2     SETHEX  LDX  #HEXDEC
337  86 D6     SETTAB  STX  XTABLE
339  85 D8             STA  LIMIT
33B  20 83 03          JSR  DIRADR
```

RSTART calls a subroutine CLRDSP which clears that portion of the display specified by Param2 and Param3 as the display limits. It then sets a value called current pointer CURPNT to equal Param2 the start location. This initializes the input routine and is also used to reinit in the event that a special character to clear the display is received, the PC key. The PC key may be used at any time to clear that portion of the display under control of the current function. Remember that as little as one character may be specified by these input functions, and that the display may at any time consist of sections which were input or generated by other functions. Param2 and Param3 totally define the portion of the display that will be affected by the current function.

```
33E  20 97 03  RSTART  JSR  CLRDSP
341  A5 B2             LDA  PARAM2
343  85 DA             STA  CURPNT
345  10 03             BPL  MORE
```

SAVE is skipped over the first time since there is no input data to be stored. MORE performs several functions. First it calls a subroutine to convert the raw data in the Param1 defined buffer to displayable form in the display buffer. It specifies the conversion table by loading X with a pointer to the correct conversion table. CONDSP is on page 18. A call is then made to EXSET to permit the Monitor to gain control for a millisecond cycle and to permit keypad input. The location CHAR will contain a 20 if there has been no input or the value of the input if there was any. The CHAR is moved to A and the location reset to 20. Then a test is made for the "erase" key, the PC key. If the last character was a PC then the program branches to RSTART. If there was no character, then the program branches to MORE. If there was a character, then it is tested for the limit. If the input character is less then the limit, then it is saved by branching to SAVE which calls a store the character subroutine STORE. If the input character is equal to or greater than the limit, then the function exits to the next step NXTSTP after storing the final character value in KEYVAL for testing by other functions.

```
347  20 D0 03  SAVE    JSR  STORE
34A  A6 D6     MORE    LDX  XTABLE
34C  20 A9 03          JSR  CONDSP
34F  20 D9 17          JSR  EXSET
352  A5 DB             LDA  CHAR
354  A2 20             LDX  #20
356  86 DB             STX  CHAR
358  C9 14             CMP  #PC
35A  F0 E2             BEQ  RSTART
35C  10 EC             BPL  MORE
35E  C5 D8             CMP  LIMIT
360  30 E5             BMI  SAVE

362  85 DF     FINISH  STA  KEYVAL
364  10 9E             BPL  NXTSTP
```

Any of the "control" keys except PC will cause termination of the input function. This means that GO, +, AD or DA may be used as valid terminators. Because the final character is saved in KEYVAL, a BRTABL Function can be used to branch within the program as a function of the terminator. This feature is used in the ADDSUB Program.

Subroutine: DIRADR
Purpose: Move Page Zero Direct Address value from Param1 to the full address pointers ADRLO/ADRHI for general use.

```
383  A5 B1     DIRADR  LDA  PARAM1
385  85 B4             STA  ADRLO
387  A9 00             LDA  #00
389  85 B5             STA  ADRHI
38B  60                RTS
```

Subroutine: INDADR

Purpose: To move a pair of Page Zero bytes which contain a full memory address from the location pointed to by Paraml to the full address pointers ADRLO/ADRHI for general use. This permits a full two byte address to be referenced by a single byte parameter. This subroutine is used by the Branch on Table Lookup Function BRTABL to point to the table to be searched.

```
38C  A6 B1     INDADR  LDX  PARAM1
38E  B5 00     XNDADR  LDA  0,X
390  85 B4             STA  ADRLO
392  B5 01             LDA  1,X
394  85 B5             STA  ADRHI
396  60                RTS
```

Subroutine: CLRDSP

Purpose: To Clear that portion of the Display defined by Param2 and Param3 by filling it with nulls.

Subroutine: FILDSP

Purpose: To Fill that portion of the Display defined by Param2 and Param3 with the value contained in the Accumulator.

These two subroutines use the same code except that CLRDSP sets a value of FF in the Accumulator as a special value which will be converted to a blank by the CONDSP subroutine.

```
397  A9 FF     CLRDSP  LDA  #FF
399  A2 06     FILDSP  LDX  #06
39B  86 D7             STX  TEMP
39D  A4 B2             LDY  PARAM2
39F  84 DA             STY  CURPNT

3A1  20 D0 03  FILNXT  JSR  STORE
3A4  C6 D7             DEC  TEMP
3A6  D0 F9             BNE  FILNXT
3A8  60                RTS
```

These routines actually do not directly effect the display. They work by modifying the data in the memory storage area which is then converted and moved to the Display buffer by the CONDSP routine. They are special purpose routines and are intended for use with the Keypad Input routines ALPIN, HEXIN and DECIN. There is a FILL Function for more general memory filling and clearing.

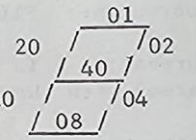
Subroutine: CONDSP

Purpose: Convert data from binary form to LED Segment Display Format.

The KIM-1 Display consists of six elements each of which in turn is composed of seven independent light emitting diode LED segments. Each segment is turned on or off under program control. The seven segments each have a binary value as shown in the diagram.

For example, to show the digit "8" all segments are turned on by putting a 7F on the display output lines. 7F = 40 + 20 + 10 + 08 + 04 + 02 + 01. The letter "L" has a value of 38 = 20 + 10 + 08. Since the display values of the various characters bear no relation to their binary form, a translation is required. The binary value 08 will be displayed as an eight "8" in Hexidecimal or Decimal mode and as ell "L" in Alpha mode. The convert to display subroutine CONDSP performs this conversion. On entry X contains the address of a Page Zero location which has the low order address of a conversion table, followed by a byte which contains the high order address of the table. Normally PLEASE supports two tables: ALPHA and HEXIDECIMAL as described on page 9. The programmer could make other tables to suit his own needs. CONDSP moves the table address to a standard Page Zero pair of locations for easy use. It picks up the Param2 address for Start Location. Locations ADRLO/ADRHI point to the buffer.

```
3A9  B5 00    CONDSP  LDA  0,X
3AB  85 D0            STA  DTABLO
3AD  B5 01            LDA  1,X
3AF  85 D1            STA  DTABHI
3B1  A4 B2            LDY  PARAM2
```




CON saves the current location. It then picks up the character in the buffer and tests it for a negative value. Normally the value of a character being output must range between Ø and F, or Ø and 9 for decimal. A negative value is used to cause a blank output. This is why CLRDSP filled the buffer with FF not ØØ. A positive value is used to perform the table lookup for the translated value. The value from the table is placed in the display buffer. Tests are made against Param3 to determine if all positions have been converted, or if not which direction to shift the pointer to handle both fillin and shift modes of input.

```
3B3  84 D7    CON     STY  TEMP
3B5  B1 B4            LDA  (ADRLO),Y
3B7  10 04            BPL  CON2
3B9  A9 00            LDA  #00
3BB  F0 03            BEQ  CON3
3BD  A8       CON2    TAY
3BE  B1 D0            LDA  (DTABLO),Y
3C0  A4 D7    CON3    LDY  TEMP
3C2  91 CE            STA  (DSPLO),Y
3C4  C4 B3            CPY  PARAM3
3C6  F0 27            BEQ  RETURN
3C8  30 03            BMI  INCR
3CA  88               DEY
3CB  10 E6            BPL  CON
3CD  C8       INCR    INY
3CE  10 E3            BPL  CON
```

Subroutine: STORE

Purpose: To place data in a buffer with parameters controlling the amount of data and the mode of storing: fillin or shift.

STORE is an integral part of the Keypad Input routines. Before it is called the address of the storage buffer is placed in the standard Page Zero locations ADRLO/ADRHI. Param2 determines the Start of storage within the buffer, Param3 determines the End, and the relative values of Param2 and Param3 determine whether the mode is fillin or shift. The character to be stored is in the Accumulator on entry. The character is saved in X. A test is made for mode by comparing Param2 and Param3. If Param3 is greater than Param2 or equal, then fillin mode is used. A test is made for end of buffer by comparing Param3 with the current pointer CURPNT. If Param3 is greater than the CURPNT, then CURPNT is incremented and the character is stored. If Param3 is less than CURPNT, then an immediate return is made and no character is stored.

```
3D0  AA        STORE   TAX
3D1  A4 B3             LDY  PARAM3
3D3  C4 B2             CPY  PARAM2
3D5  30 0A             BMI  SHIFT
3D7  C4 DA             CPY  CURPNT
3D9  30 14             BMI  RETURN
3DB  A4 DA             LDY  CURPNT
3DD  E6 DA             INC  CURPNT
3DF  10 0C             BPL  PUT
```

If Param3 was less than Param2 then shift mode is used. SHIFT first moves all characters within the portion of the buffer defined by Param2 and Param3 one position up in memory. When all characters have been shifted it gets the new character back from X and stores it in the buffer at the last position as defined by Param3.

```
3E1  C8        SHIFT   INY
3E2  B1 B4             LDA  (ADRLO),Y
3E4  88                DEY
3E5  91 B4             STA  (ADRLO),Y
3E7  C8                INY
3E8  C4 B2             CPY  PARAM2
3EA  30 F5             BMI  SHIFT
3EC  8A                TXA
3ED  91 B4     PUT     STA  (ADRLO),Y
3EF  60        RETURN  RTS
```

Function: ALPOUT Code: Ø3

Purpose: Convert and Display data in Alpha mode, using standard PLEASE Alpha Table.

Command: ALPOUT
Param1: Memory Address of Buffer. Page Zero Locations.
Param2: Start Display Location. Leftmost = Ø, Rightmost = 5.
Param3: End Display Location. Leftmost = Ø, Rightmost = 5.

Data to be output should be in range ØØ to ØF for real data or FF for a blank. Other values will give strange results. The Alpha Table on page 9 shows the standard conversions. The order of the Start and End does not matter. Start less than End will be handled as fillin and End less than Start will be handled as shift, but since the whole conversion takes place within a single millisecond cycle there will be no visible difference.

Function: HEXOUT or DECOUT Code: Ø4

Purpose: Convert and Display data in Hexidecimal mode, using standard KIM-1 Hexidecimal Table.

Command: HEXOUT or DECOUT
Param1: Memory Address of Buffer. Page Zero Locations.
Param2: Start Display Location. Leftmost = Ø, Rightmost = 5.
Param3: End Display Location. Leftmost = Ø, Rightmost = 5.

Data to be output should be in range ØØ to ØF for Hex or ØØ to Ø9 for Decimal. A value with bit 8Ø set will produce a blank. Values in the range 1Ø to 7F will give strange results. See ALPOUT comments above for other details. HEXOUT is the entry point for HEXOUT/DECOUT.

```
283  A2 D4     ALPOUT  LDX  #ALPHLO
285  D0 02             BNE  GETADR
287  A2 D2     HEXOUT  LDX  #HEXDEC
289  20 83 03  GETADR  JSR  DIRADR
28C  20 A9 03             JSR  CONDSP
28F  4C 04 03  TONEXT   JMP  NXTSTP
```

For an example of the use of ALPOUT see the HiLo program.
For an example of the use of HEXOUT and DECOUT see the Decimal/Hexidecimal Conversion program.

Function: TIMER

Code: Ø5

Purpose: Provide a programmable delay while maintaining the basic system operations of Display Refresh and System Clock Updating.

Command: TIMER
Param1: Delay Time in Tenths of a Second. Range 0.1 to 25.6 seconds.
Param2: Step Number to Branch to when Delay is done.
Param3: not used

There are a number of uses for a timer. Several programs flash all or part of the Display. This is easily accomplished by changing all or part of the Display, waiting a set period of time using TIMER, changing the Display again, waiting, and so forth. Another use for TIMER is in TIPSY in which the Player is shown the test numbers for 2 seconds and then must wait 1 second before typing his answer. The basic unit of TIMER is 0.1 seconds. This is generated from the Monitor Millisecond loop by setting up two counters to provide a 100 millisecond = 0.1 second delay. Intermediate returns are made to the Monitor to permit the basic system operations to take place and to complete the millisecond loop. After 0.1 seconds have been timed, the Delay Time is decremented and tested. If the Delay Time has gone to zero, then the next Step Number is pickup and a return is made to the Interpreter at the Set Step SETSTP location. Delay Time is held in Param1 and next Step Number in Param2.

```
2AA  A9 0A      TIMER   LDA  #10.
2AC  85 BE              STA  TEMP1
2AE  A9 0A      RESET   LDA  #10.
2B0  85 BF              STA  TEMP2
2B2  20 D9 17   WAIT    JSR  EXSET
2B5  C6 BF              DEC  TEMP2
2B7  D0 F9              BNE  WAIT
2B9  C6 BE              DEC  TEMP1
2BB  D0 F1              BNE  RESET
2BD  C6 B1              DEC  PARAM1
2BF  D0 E9              BNE  TIMER
2C1  A5 B2              LDA  PARAM2
2C3  10 3D              BPL  SETSTP
```

Warning: Remember that the Delay Time in Param1 is in tenths of a second.

Note: Obviously only a single counter is required to keep a 100. count. The double counter is provided so that a longer base interval can be generated by changing the two counter constants. The maximum base interval would be slightly over one minute (65,536 milliseconds) which means that a delay can be specified of over four hours (256+ minutes) if the base interval is changed. An even longer interval could be generated by having multiple TIMER calls. However, since the TIMER is based on the crystal and a slight variation in time can cause a large error when accumulated over millions of cycles, this TIMER will not be very accurate for long periods.

Function: PACK Code: Ø6

Purpose: To take a series of characters and pack them two to a byte.

Command: PACK
Param1: Source Buffer which contains Characters. Page Zero.
Param2: Destination Buffer or Byte to receive result. Page Zero.
Param3: Number of Bytes in the Destination

While it is convenient to input characters in four bit chunks and keep them that way for displaying, it is often an inconvenient form for processing data. PACK provides a simple method of combining the raw input data into compact bytes. An input character must be in the range ØØ to ØF. Two such characters fit into a single byte. PACK can handle as little as one byte or as many as 256. PACK picks up the first character of the pair to be packed and shifts it into the Most Significant Bits of the Accumulator and then performs a logical inclusive Or to get the second character into the Least Significan Bits. It then tests the Carry bit to see if a dummy blank character FF was the first character. If it was it loads the second character into the Accumulator and test if it was a blank character. If it was it loads zero as the result of packing two blank characters. If the first or second character is not a blank, then the combined characters are now stored as a single packed byte. This packing of character pairs continues until the requested number of bytes have been created.

```
23B  A6 B1     PACK    LDX  PARAM1
23D  B5 00             LDA  0,X
23F  0A                ASL
240  0A                ASL
241  0A                ASL
242  0A                ASL
243  15 01             ORA  1,X
245  90 06             BCC  PACK2
247  B5 01             LDA  1,X
249  10 02             BPL  PACK2
24B  A9 00             LDA  #00
24D  A6 B2     PACK2   LDX  PARAM2
24F  95 00             STA  0,X
251  E6 B1             INC  PARAM1
253  E6 B1             INC  PARAM1
255  E6 B2             INC  PARAM2
257  C6 B3             DEC  PARAM3
259  D0 E0             BNE  PACK
25B  F0 32             BEQ  TONEXT
```

For examples of PACK in use, see the DECODE program, SCLOCK program, or STIMER program.

Function: UNPACK Code: Ø7

Purpose: To separate bytes into characters, normally in order to make them available for displaying.

Command: UNPACK
Param1: Source Buffer which contains Bytes. Page Zero.
Param2: Destination Buffer to receive Characters. Page Zero.
Param3: Number of Characters in the Destination.

Normally data is processed in a packed form or binary form. Since the display only uses values in the range ØØ to ØF for its normal character generation, a means of converting from packed to unpacked form is required. UNPACK performs this function. One or more bytes are split into their component characters. The Most Significant Bits are used as the first character of a pair, the Least Significant Bits as the second character. UNPACK can be used to generate from one to 256 characters. UNPACK picks up the byte to be unpacked, shifts off the second character and stores the first character in the destination buffer. It then tests for any more characters required. If no more, then it is done and goes to the next step NXTSTP in the Interpreter. If more is required it masks off the second character from the same byte and stores it in the destination buffer. After some housekeeping, it test for any more characters required. If so it gets the next byte and continues. If no more are required it goes to the next step NXTSTP in the Interpreter.

```
25D  A6 B1     UNPACK  LDX  PARAM1
25F  B5 00             LDA  0,X
261  4A                LSR
262  4A                LSR
263  4A                LSR
264  4A                LSR
265  A6 B2             LDX  PARAM2
267  95 00             STA  0,X
269  E6 B2             INC  PARAM2
26B  C6 B3             DEC  PARAM3
26D  F0 1E             BEQ  TONEXT
26F  A6 B1             LDX  PARAM1
271  A9 0F             LDA  #0F
273  35 00             AND  0,X
275  A6 B2             LDX  PARAM2
277  95 00             STA  0,X
279  E6 B2             INC  PARAM2
27B  E6 B1             INC  PARAM1
27D  C6 B3             DEC  PARAM3
27F  D0 DC             BNE  UNPACK
281  F0 0C             BEQ  TONEXT
```

For examples of UNPACK in use see DCLOCK program, DTIMER program, or the Shooting Stars program.

Function: BRANCH Code: Ø8

Purpose: Provides an Unconditional Branch to any specified Step.

Command: BRANCH
Param1: Step to Branch To.
Param2: not used
Param3: not used

Almost every conceivable PLEASE program has one or more loops in it or is itself a large loop. The BRANCH function permits transfer of control to a Step other than the next sequential Step. BRANCH picks up the Step number from Param1 and then goes to the Set Step SETSTP entry of the Interpreter.

```
2A6  A5 B1     BRANCH  LDA  PARAM1
2A8  10 58             BPL  SETSTP
```

Function: BRCHAR Code: Ø9

Purpose: Provide Program Control from the Keypad.

Command: BRCHAR
Param1: Character for Match.
Param2: Step to Branch to on Match.
Param3: Step to Branch to on Non-match.

BRCHAR picks up the current value of the Page Zero location CHAR which contains the last input character or a 20 if there is no valid input. It clears the CHAR location and tests for valid input. If there is no character ready, then a return is made to the Next Step NXTSTP entry of the Interpreter and the next Step is executed. If there is a character it is tested for a match with the specified match character in Param1. If they match, then the Match Step in Param2 is used as the next step. If they do not match, then the Non-match Step in Param3 is used. In either case the parameter value is loaded into the Accumulator and control goes to the Set Step SETSTP entry of the Interpreter.

```
292  A6 DB     BRCHAR  LDX  CHAR
294  A9 20             LDA  #20
296  85 DB             STA  CHAR
298  E0 20             CPX  #20
29A  F0 F3             BEQ  TONEXT
29C  A5 B2             LDA  PARAM2
29E  E4 B1             CPX  PARAM1
2A0  F0 02             BEQ  OKAY
2A2  A5 B3             LDA  PARAM3
2A4  10 5C     OKAY    BPL  SETSTP
```

For examples of BRCHAR see DCLOCK program or DTIMER program.

Function: BRTABL Code: ØA

Purpose: Provide Program Control as a function of a Table Lookup.

Command: BRTABL
Param1: Page Zero Indirect Address of Table.
Param2: Direct Address of Value to be Matched. Page Zero.
Param3: Step Number to Branch to if No Match.

This is a very powerful method of branching. A value may be generated by any means such as characters from the Keypad, result of a calculation, or whatever. A table is set up which contains the permitted values and the step number to go to if that value occurs. Many value can branch to the same Step. Every value may branch to a different Step. The table could itself be modified and/or generated under the program. BRTABL starts by calling the INDADR subroutine to move the table address into the standard locations ADRLO/ADRHI. It ther picks up the test value via Param2 and compares it with a value in the table. If a match is found, then the next byte in the table is picked up and used as the next step number by going to the Set Step SETSTP entry of the Interpreter. If it is not a match, then the pointers are moved to the next value in the table which is checked for zero. If the next value is a zero it indicates the end of the table and a no match condition. In this case the value of Param3 is used as the nest step number via the Set Step SETSTP entry to the Interpreter. If the next value is not a zero, then BRTABL continues testing until either a match is found or the end of the table is reached.

```
366  20 8C 03  BRTABL  JSR  INDADR
369  A6 B2             LDX  PARAM2
36B  A0 00             LDY  #00

36D  B5 00     MORE    LDA  0,X
36F  D1 B4             CMP  (ADRLO),Y
371  F0 0A             BEQ  FOUND
373  C8                INY
374  C8                INY
375  B1 B4             LDA  (ADRLO),Y
377  D0 F4             BNE  MORE
379  A5 B3             LDA  PARAM3
37B  10 85     BRDONE  BPL  SETSTP

37D  C8        FOUND   INY
37E  B1 B4             LDA  (ADRLO),Y
380  10 F9             BPL  BRDONE
```

The table has two bytes per entry. The first byte is the value to be tested. The second value is the Step Number to go to on a match. The table must be terminated by a zero value, therefore, zero may not be used for a test value unless it is the first test value which is matched before the end of table test is performed. For examples of BRTABL see the DECODE program or the ADDSUB program.

Code: ØB

Function: FILL

Purpose: Provide a means of filling a section of Page Zero memory with a specified value.

Command: FILL
Param1: Memory Address of Start of Page Zero Memory to be Filled.
Param2: Value to Fill Memory with.
Param3: Number of bytes of Memory to Fill.

Since all of the working locations, buffers, and so forth for PLEASE are in Page Zero, this limited Fill command is sufficient for most purposes. It is used to initialize buffers, clear specific bytes, clear the Display via its buffer, etc. FILL first calls the DIRADR subroutine to get the Page Zero address to be modified into the standard ADRLO/ADRHI location. It then picks up the Fill value from Param2 and proceeds to fill memory starting at the last location to be modified and working back to the first location. When finished it returns via the Next Step NXTSTP entry in the Interpreter.

```
2E9  20 83 03  FILL    JSR  DIRADR
2EC  A5 B2             LDA  PARAM2
2EE  A4 B3             LDY  PARAM3
2F0  88                DEY

2F1  91 B4     FILLIT  STA  (ADRLO),Y
2F3  88                DEY
2F4  10 FB             BPL  FILLIT
2F6  30 0C             BMI  NXTSTP
```

For examples of FILL see the DECODE program or the DAFFY program.

Function: COMPARE Code: ØC

Purpose: Provide a String Compare with a Three-way Branch on Less, Equal, or Greater.

Command: COMPAR
Param1: Page Zero Address of Test Value Start
Param2: Page Zero Address of String to be Compared with.
Param3: Number of Bytes to be Compared.

Function: MATCH Code: ØD

Purpose: Provide a String Compare with a Two-way Branch on Equal or Not Equal.

Command: MATCH
Param1: Page Zero Address of Test Value Start
Param2: Page Zero Address of String to be Matched to.
Param3: Number of Bytes to be Matched.

These two functions use essentially the same code. The only difference is a test which causes MATCH to treat Less and Greater as a single condition: Not Equal. First a call is made to the DIRADR subroutine to get the Test String address in the standard ADRLO/ADRHI locations. A byte from the second string is picked up. A byte from the first string is subtracted from the second string byte and the result tested. If the first string byte is less than the second string, then testing is complete and control is returned to the Interpreter through the Next Step NXTSTP entry point. If the first string byte is greater than the second string byte, then an additional test is made to determine if this is a COMPAR or MATCH. If a MATCH, then it is treated identically as the **less.** If a COMPAR, then the Step Number STEPNO is incremented twice to cause the next two Steps to be skipped. If the first and second bytes are equal, then the number of bytes to test is checked. If all bytes have been tested, then the Step Number STEPNO is increment once to cause the next Step to be skipped. If all bytes have not been tested, then testing continues with the next pair of bytes.

COMPAR and MATCH Branch Summary: First String to Second String

COMPARE

| | |
|---|---|
| Less | Skip Ø Steps |
| Equal | Skip 1 Step |
| Greater | Skip 2 Steps |

MATCH

| | |
|---|---|
| Less | Skip Ø Steps |
| Equal | Skip 1 Step |
| Greater | Skip Ø Steps |

```
2C5  20 83 03  COMPAR  JSR  DIRADR
2C8  A6 B2             LDX  PARAM2
2CA  A0 00             LDY  #00

2CC  B5 00     CTEST   LDA  0,X
2CE  38                SEC
2CF  D1 B4             SBC  (ADRLO),Y
2D1  F0 0E             BEQ  SAME
2D3  B0 0A             BCS  LESS

2D5  A9 0D     GREAT   LDA  #MATCH
2D7  C5 B0             CMP  PARAMØ
2D9  F0 04             BEQ  LESS
2DB  E6 B7             INC  STEPNO
2DD  E6 B7     EQUAL   INC  STEPNO

2DF  10 23     LESS    BPL  NXTSTP

2E1  E8        SAME    INX
2E2  C8                INY
2E3  C4 B3             CPY  PARAM3
2E5  D0 E5             BNE  CTEST
2E7  F0 F4             BEQ  EQUAL
```

For examples of COMPARE see the HILO program.
For examples of MATCH see the TIPSY program.

Program Module #1

| LOC | OBJECT | STEP | LABEL | COMMAND | PARAM1 | PARAM2 | PARAM3 |
|---|---|---|---|---|---|---|---|
| | | | | Command Decoder | | | |
| 00 | 00E00005 | Ø | DECODE | ALPIN | BUFFER | Ø | 5 |
| 04 | 06E0DF01 | 1 | | PACK | BUFFER | KEYVAL | 1 |
| 08 | 0BC80006 | 2 | | FILL | DISPLAY | Ø | 6 |
| 0C | 0ADCDF00 | 3 | | BRTABL | CMDTBL | KEYVAL | DECODE |
| | | | | Set Clock and Display Clock | | | |
| 10 | 02E00005 | 4 | SCLOCK | DECIN | BUFFER | Ø | 5 |
| 14 | 06E0C403 | 5 | | PACK | BUFFER | HOUR | 3 |
| 18 | 07C4E006 | 6 | DCLOCK | UNPACK | HOUR | BUFFER | 6 |
| 1C | 04E00005 | 7 | | DECOUT | BUFFER | Ø | 5 |
| 20 | 09130004 | 8 | | BRCHAR | GO | DECODE | SCLOCK |
| 24 | 08060000 | 9 | | BRANCH | DCLOCK | | |
| | | | | Set Timer and Display Timer | | | |
| 28 | 02E00500 | A | STIMER | DECIN | BUFFER | 5 | Ø |
| 2C | 06E0C103 | B | | PACK | BUFFER | TENS | 3 |
| 30 | 07C1E006 | C | DTIMER | UNPACK | TENS | BUFFER | 6 |
| 34 | 04E00005 | D | | DECOUT | BUFFER | Ø | 5 |
| 38 | 0913000A | E | | BRCHAR | GO | DECODE | STIMER |
| 3C | 080C0000 | F | | BRANCH | DTIMER | | |
| | | | | Notice and Billboard | | | |
| 40 | 11D0010A | 10 | NOTICE | MESAGE | NMSGLO | MSGHI | 10. |
| 44 | 09130013 | 11 | | BRCHAR | GO | DECODE | BILBRD |
| 48 | 08100000 | 12 | | BRANCH | NOTICE | | |
| 4C | 12CA0104 | 13 | BILBRD | BBOARD | BMSGLO | MSGHI | 4. |
| 50 | 09130010 | 14 | | BRCHAR | GO | DECODE | NOTICE |
| 54 | 08130000 | 15 | | BRANCH | BILBRD | | |
| | | | | Daffy | | | |
| 58 | 0BE00006 | 16 | DAFFY | FILL | ANSWER | Ø | 6 |
| 5C | 07C1E004 | 17 | | UNPACK | TENS | ANSWER | 4 |
| 60 | 02E60003 | 18 | GET | DECIN | GUESS | Ø | 3 |
| 64 | 10E6EC20 | 19 | | MASTER | GUESS | ANSWER | BAD |
| 68 | 04E00005 | 1A | GOOD | DECOUT | ANSWER | Ø | 5 |
| 6C | 05021C00 | 1B | | TIMER | 2. | BLANK | |
| 70 | 0BCC0002 | 1C | BLANK | FILL | DISPLAY+4 | Ø | 2 |
| 74 | 05011E00 | 1D | | TIMER | 1 | WAIT | |
| 78 | 09130016 | 1E | WAIT | BRCHAR | GO | DECODE | DAFFY |
| 7C | 081A0000 | 1F | | BRANCH | GOOD | | |
| 80 | 04E60405 | 20 | BAD | DECOUT | GUESS | 4 | 5 |
| 84 | 09130018 | 21 | HOLD | BRCHAR | GO | DECODE | GET |
| 88 | 08210000 | 22 | | BRANCH | HOLD | | |

DECODE Command Decoder

This program is called when the system is initialized or when various programs are complete. Its purpose is to allow the user to select a program from the keypad. ALPIN is used to input the program name from the keypad. At least two characters of the name must be typed, additional characters are optional. PACK is used to combine the first two characters into a single byte for testing by BRTABL. FILL is used to clear the display by filling the display buffer with nulls. BRTABL is used to lookup in the Command Table CMDTBL the Step Number STEPNO of the requested program and to transfer control to that program.

SCLOCK and DCLOCK Set Clock and Display Clock

These programs set the system clock and display the current contents of the system clock. DECIN is used to input up to six characters in the fillin mode. PACK converts the input characters into three bytes in the system clock. UNPACK converts the current contents of the system clock into separate characters. DECOUT converts these characters into their displayable form and moves them to the display buffer. BRCHAR returns to DECODE if the GO key is pressed; goes to SCLOCK if any other key is pressed; or goes to the next step if no key is pressed. BRANCH which is reached by no key being pressed goes to DCLOCK so that the display is constantly updated with the current value of the system clock.

STIMER and DTIMER Set Timer and Display Timer

These programs set the system timer and display the current contents of the system timer. DECIN is used to input up to six characters in the shift mode. The remainder of the program is identical to SCLOCK and DCLOCK described above.

NOTICE and BILBRD Notice and Billboard Message Display

These programs display a message in alphabetic characters. NOTICE displays six characters per frame for one second per frame. BILBRD displays its characters by shifting them in one at a time from the right to the left at a shift rate of one shift every 0.4 seconds. MESAGE/BBOARD call the same routine, the only difference being an internal test performed on the value of the command MESAGE = 11 and BBOARD = 12 which determines how the data is presented. BRCHAR goes to DECODE on a GO key; goes to the other program on any other key NOTICE to BILBRD or BILBRD to NOTICE; or goes to the next step if no key is pressed. BRANCH goes to restart the program which causes the message to be repeated continuously until some key is pressed.

DAFFY The Daffy (Mastermind) Number Guessing Game

FILL clears the answer buffer. UNPACK is used to create an answer from the system timer. DECIN gets the users four digit decimal guess. MASTER is special code to evaluate the guess. It compares GUESS and ANSWER and if not a match, branches to BAD. On a perfect match it drops through to GOOD. The remainder of the program displays the number of guesses in a flashing mode on GOOD or the evaluation of the guess on BAD.

MESAGE and BBOARD special functions.

The NOTICE program uses a special function MESAGE to output the "canned" message six characters at a time. The BILBRD program uses a special function BBOARD to output the "canned" message one character at a time producing a moving message. Actually both MESAGE and BBOARD are the same routine, differing only by a single internal test which causes the six or one character change in the display. Both functions are called by entering at the MESAGE entry point. The value of the Command is used to determine the particular function.

Notice and Billboard

```
LOC  OBJECT      LABEL    OPERATION
                                        Initialize start of message.
190  A0 00       MESAGE   LDY  #00
192  84 BB                STY  PLACE
                                        Get next character.
194  A2 00       MORE     LDX  #00
196  B1 B1       FETCH    LDA  (PARAM1),Y  If character is minus, then
198  10 03                BPL  OKAY        end of message.
19A  4C 04 03             JMP  NXTSTP
                                        Store character is display
19D  95 C8       OKAY     STA  DSPØ,X     buffer.  Bump pointers.
19F  C8                   INY
1A0  E8                   INX
                                        Test six characters done.
1A1  E0 06                CPX  #6
1A3  D0 F1                BNE  FETCH       If not, get next.
                                        Get message place pointer.
1A5  A5 BB                LDA  PLACE
                                        Test MESAGE or BILBRD
1A7  A2 12                LDX  #12
1A9  E4 B0                CPX  PARAMØ      If MESAGE, then move place
1AB  F0 02                BEQ  INCR        pointer forward six places.
1AD  69 05                ADC  #5          If BILBRD, then move one
1AF  69 00       INCR     ADC  #0          place.
                                        Save modified PLACE.
1B1  85 BB                STA  PLACE
                                        Get Delay from PARAM3
1B3  A5 B3                LDA  PARAM3
1B5  85 BE                STA  PTEMPØ
                                        Set 1/10 second timer.
1B7  A9 64       SETIME   LDA  #100.
1B9  85 BF                STA  PTEMP1
                                        Wait 1 millisecond
1BB  20 D9 17    WAIT     JSR  EXSET
                                        Bump 1/10 second counter
1BE  C6 BF                DEC  PTEMP1
                                        until zero.
1C0  D0 F9                BNE  WAIT
                                        Then bump Delay counter
1C2  C6 BE                DEC  PTEMPØ
                                        until zero.
1C4  D0 F1                BNE  SETIME
                                        Now get next frame of the
1C6  A4 BB                LDY  PLACE
                                        message.
1C8  10 CA                BPL  MORE
```

Message for Notice and Billboard

```
1CA   00 00 00 00 00 00        Blanks for Billboard
1D0   73 38 79 77 6D 79        PLEASE
1D6   00 39 77 37 00 30         CAN I
1DC   00 76 79 38 73 00         HELP
1E2   00 53 00 00 00 00         ?
1E8   00 00 00 00 00 00        Trailing blanks
1EE   FF                       Terminator
```

```
LOC  OBJECT     LABEL    OPERATION

130  20 83 03   MASTER   JSR  DIRADR      Address of Guess
133  A6 B2               LDX  PARAM2      Bump Guesses Counter
135  F6 05               INC  5,X
137  A9 0A               LDA  #0A         Test Units digit = 10.
139  D5 05               CMP  5,X
13B  D0 06               BNE  TEST
13D  A9 00               LDA  #0          Set Units = 0.
13F  95 05               STA  5,X         Incr Tens digit
141  F6 04               INC  4,X

143  A9 00      TEST     LDA  #0          Clear Evaluation
145  85 BE               STA  PTEMPØ      Counters
147  85 BF               STA  PTEMP1
149  A0 03               LDY  #3          Set Digit Counter
14B  B1 B4      PTEST    LDA  (ADRLO),Y   Get a Guess Character
14D  D5 03               CMP  3,X         Test Correct Char.
14F  D0 02               BNE  NOTPER      in Correct Location.
151  E6 BE               INC  PTEMPØ      Bump Counter
153  CA         NOTPER   DEX              Test all four Guess
154  88                  DEY              Characters.
155  10 F4               BPL  PTEST

157  A6 B2               LDX  PARAM2      Test Correct without
159  A9 03               LDA  #3          regard to position.
15B  85 D7               STA  TEMP
15D  A0 03      SETUP    LDY  #3
15F  B5 03      MATCH    LDA  3,X         Get Answer Digit
161  D1 B4               CMP  (ADRLO),Y   Test Match
163  D0 08               BNE  NMATCH
165  A9 FF               LDA  #FF         If Match, wipe out the
167  91 B4               STA  (ADRLO),Y   Guess digit to prevent
169  E6 BF               INC  PTEMP1      multiple matches.
16B  10 03               BPL  NEXT
16D  88         NMATCH   DEY              If No-match, keep trying
16E  10 EF               BPL  MATCH
170  CA         NEXT     DEX              Get next Answer digit
171  C6 D7               DEC  TEMP        until all four done.
173  10 E8               BPL  SETUP

175  A0 04               LDY  #4          Test Perfect Match on
177  C4 BE               CPY  PTEMPØ      all four digits.
179  F0 04               BEQ  DONE        If so, then done.
17B  A5 B3               LDA  PARAM3      Else, use PARAM3 for next
17D  85 B7               STA  STEPNO      Step Number.
17F  A5 BE      DONE     LDA  PTEMPØ      Move Evaluation counters
181  91 B4               STA  (ADRLO),Y   to Guess Buffer for
183  C8                  INY              displaying.
184  A5 BF               LDA  PTEMP1
186  91 B4               STA  (ADRLO),Y
188  4C 04 03            JMP  NXTSTP
```

Program Module #2

| LOC | OBJECT | STEP | LABEL | COMMAND | PARAM1 | PARAM2 | PARAM3 |
|---|---|---|---|---|---|---|---|
| | | | | Command Decoder | | | |
| 00 | 00E00005 | Ø | DECODE | ALPIN | BUFFER | Ø | 5 |
| 04 | 06E0DF01 | 1 | | PACK | BUFFER | KEYVAL | 1 |
| 08 | 0BC80006 | 2 | | FILL | DISPLAY | Ø | 6 |
| 0C | 0ADCDF00 | 3 | | BRTABL | CMDTBL | KEYVAL | DECODE |
| | | | | Shooting Stars | | | |
| 10 | 10000000 | 4 | STAR | START | | | |
| 14 | 01E00303 | 5 | NEXT | HEXIN | BUFFER | 3 | 3 |
| 18 | 110B0E00 | 6 | | SHOT | LOSE | WIN | |
| 1C | 07E6E402 | 7 | RUN | UNPACK | COUNT | BUFFER+4 | 2 |
| 20 | 04E00405 | 8 | | DECOUT | BUFFER | 4 | 5 |
| 24 | 09130005 | 9 | RWAIT | BRCHAR | GO | DECODE | NEXT |
| 28 | 08090000 | A | | BRANCH | RWAIT | | |
| 2C | 0BCC5302 | B | LOSE | FILL | DISPLAY+4 | "?" | 2 |
| 30 | 09130004 | C | WAIT | BRCHAR | GO | DECODE | STAR |
| 34 | 080C0000 | D | | BRANCH | WAIT | | |
| 38 | 07E6E402 | E | WIN | UNPACK | COUNT | BUFFER+4 | 2 |
| 3C | 04E00405 | F | | DECOUT | BUFFER | 4 | 5 |
| 40 | 080C0000 | 10 | | BRANCH | WAIT | | |
| | | | | HILO Number Guessing Game | | | |
| 44 | 0BE6FF06 | 11 | HILO | FILL | GUESS | FF | 6 |
| 48 | 07C2E402 | 12 | | UNPACK | TENTHS | BUFFER+4 | 2 |
| 4C | 09130015 | 13 | WAIT | BRCHAR | GO | DECODE | READY |
| 50 | 08130000 | 14 | | BRANCH | WAIT | | |
| 54 | 0BCC0002 | 15 | READY | FILL | DISPLAY+4 | Ø | 2 |
| 58 | 02E60001 | 16 | | DECIN | GUESS | Ø | 1 |
| 5C | 0CE6E402 | 17 | | COMPARE | GUESS | BUFFER+4 | 2 |
| 60 | 081C0000 | 18 | | BRANCH | LOW | | |
| 64 | 081E0000 | 19 | | BRANCH | EQUAL | | |
| 68 | 036A0405 | 1A | HIGH | ALPOUT | HI | 4 | 5 |
| 6C | 08130607 | 1B | | BRANCH | WAIT | "H | "I |
| 70 | 03720405 | 1C | LOW | ALPOUT | LO | 4 | 5 |
| 74 | 0813080A | 1D | | BRANCH | WAIT | "L | "O |
| 78 | 04E00405 | 1E | EQUAL | DECOUT | BUFFER | 4 | 5 |
| 7C | 05012000 | 1F | | TIMER | 1 | BLANK | |
| 80 | 0BCC0002 | 20 | BLANK | FILL | DISPLAY+4 | Ø | 2 |
| 84 | 05012200 | 21 | | TIMER | 1 | NEXT | |
| 88 | 09130011 | 22 | NEXT | BRCHAR | GO | DECODE | HILO |
| 8C | 081E0000 | 23 | | BRANCH | EQUAL | | |

Program Module #2 Notes and Comments

DECODE Command Decoder See page 29.

STAR Shooting Stars Puzzle

This is the puzzle described by Willard I Nico in the May 1976 issue of BYTE, and described and implemented by a number of other individuals since. START initializes the puzzle by setting up the initial star map, clearing the number of guesses counter, and so forth. HEXIN accepts a single input from the user and displays it in position 3 of the display. SHOT evaluates the user's shot. If the shot is invalid, that is it is not an existing star, then the display is changed to a question mark and the shot is not counted. If the shot is valid a complex table lookup is performed which produces the required changes in the galaxy. The result is then evaluated. If all stars have vanished the program branches to LOSE. If the winning position has been achieved the program branches to WIN. Otherwise the program continues at RUN. UNPACK and DECOUT are used to display the current shot count. BRCHAR and BRANCH are used to wait for the user to press either GO to give up and return to DECODE or to press any other key and go to NEXT for the next shot. LOSE uses FILL to put two question marks in the count field of the display to indicate the loss. WIN uses UNPACK and DECOUT to display the final shot count. Both WIN and LOSE go to WAIT and use BRCHAR and BRANCH to wait for a GO to return to DECODE or any other key to go to STAR and restart the game.

HILO High/Low Simple Number Guessing Game

FILL and UNPACK use the system timer to generate a two digit decimal value. WAIT uses BRCHAR and BRANCH to wait until the user presses any key to continue or GO to return to DECODE. READY uses FILL to clear the old message HI or LO and DECIN to get the new guess. COMPARE evaluates the guess and in conjunction with BRANCH goes to LOW, EQUAL, or HIGH. HIGH or LOW use ALPOUT to display the appropriate message and then BRANCH to WAIT. EQUAL uses the sequence of functions DECOUT, TIMER, FILL, TIMER, BRCHAR, and BRANCH to flash the correct answer until a GO is pressed for DECODE or any other key is pressed for another round of HILO.

SHOOTING STARS - Shot Map

| LOC | SHOT | POS | GALAXY | CENTER |
|---|---|---|---|---|
| 1C0 | 0 | 08 | 68 | 01 |
| 1C4 | 1 | 20 | 38 | 00 |
| 1C8 | 2 | 10 | B0 | 01 |
| 1CC | 4 | 40 | 49 | 00 |
| 1D0 | 5 | 00 | E4 | 01 |
| 1D4 | 6 | 80 | 92 | 00 |
| 1D8 | 8 | 01 | 45 | 01 |
| 1DC | 9 | 04 | 07 | 00 |
| 1E0 | A | 02 | 86 | 01 |

Shooting Stars

```
LOC   OBJECT     LABEL    OPERATION

130   A9 00      START    LDA  #Ø          Initialize Shooting Stars
132   85 E6               STA  COUNT       Clear Shot Counter
134   85 E7               STA  UNIV        Clear Universe
136   A9 01               LDA  #1          Set Center Star
138   85 E8               STA  CENTER      to be on
13A   10 47               BPL  FIRST       Go Map Universe to Display

13C   A9 C0      SHOT     LDA  #MAP        Shot Evaluation
13E   85 B4               STA  ADRLO       Set ADRLO/ADRHI to
140   A9 01               LDA  #1          point to Shot Map
142   85 B5               STA  ADRHI
144   A0 00               LDY  #Ø
146   A5 E3      SEARCH   LDA  BUFFER+3    Get current shot value
148   D1 B4               CMP  (ADRLO),Y   Test Shot Map match
14A   F0 0B               BEQ  MATCH       Branch on match
14C   98                  TYA              Else set for next position
14D   18                  CLC              in Shot Map.
14E   69 04               ADC  #4          Four bytes per entry
150   C9 24               CMP  #36.        Test end of Shot Map
152   F0 20               BEQ  NMATCH      for Invalid Shot
154   A8                  TAY              Set to get next.
155   10 EF               BPL  SEARCH      Continue Search
157   C8         MATCH    INY              Set for next byte
158   B1 B4               LDA  (ADRLO),Y   Get POS from Shot Map
15A   F0 14               BEQ  CTEST       Test Center
15C   25 E7               AND  UNIV        Else mask to see if Star
15E   F0 14               BEQ  NMATCH      exists.  If not, invalid.
160   C8         FIX      INY              Set for next byte.
161   B1 B4               LDA  (ADRLO),Y   Get GALAXY
163   45 E7               EOR  UNIV        Exclusive OR to turn on/off
165   85 E7               STA  UNIV        associated Stars.
167   C8                  INY              Set for next byte.
168   B1 B4               LDA  (ADRLO),Y   Get Center value
16A   45 E8               EOR  CENTER      Exclusive OR
16C   85 E8               STA  CENTER
16E   10 0A               BPL  SHOWIT
170   A5 E8      CTEST    LDA  CENTER      Test if Center Exists
172   D0 EC               BNE  FIX         Okay if Center Exists
174   A9 53      NMATCH   LDA  #53         Invalid Shot.  Show a
176   85 CB               STA  DSP3        Question Mark in Shot
178   10 41               BPL  RUN         position of display.
```

```
LOC  OBJECT     LABEL    OPERATION
                SHOWIT   SED                 Increment two digit
17A  F8                  CLC                 Decimal Shot Counter
17B  18                  LDA   #01
17C  A9 01               ADC   COUNT
17E  65 E6               STA   COUNT
180  85 E6               CLD
182  D8
                FIRST    LDA   #49           Convert Universe to
183  A9 49               AND   UNIV          Display Segment Values
185  25 E7               STA   DSPØ          First Position
187  85 C8
                SECOND   LDA   #24           Mask Second Position
189  A9 24               AND   UNIV          to calculate Segments
18B  25 E7               LSR                 Shift for actual
18D  4A                  LSR                 segment values
18E  4A                  STA   DSP1
18F  85 C9               LDA   CENTER        Get Center value
191  A5 E8               BEQ   THIRD         Test on/off
193  F0 06               LDA   DSP1          ON so add in the
195  A5 C9               ADC   #40           Center segment value
197  69 40               STA   DSP1
199  85 C9
                THIRD    LDA   #92           Mask Third Position
19B  A9 92               AND   UNIV          and then shift into
19D  25 E7               STA   DSP2          correct positions
19F  85 CA               LSR   DSP2
1A1  46 CA
                TEST     LDA   UNIV          Test Empty Universe
1A3  A5 E7               BEQ   TEST2         Maybe
1A5  F0 08               CMP   #FF           Test Win Position
1A7  C9 FF               BNE   RUN           No
1A9  D0 10               LDA   CENTER        Maybe.  Win if Center
1AB  A5 E8               BEQ   WIN           position is OFF
1AD  F0 08
                TEST2    LDA   CENTER        Empty or Win
1AF  A5 E8               BNE   RUN           Not if Center is ON
1B1  D0 08
                LOSE     LDA   PARAM1        Empty Universe.  LOSE.
1B3  A5 B1               BPL   STEP          Use PARAM1 Step No.
1B5  10 02
                WIN      LDA   PARAM2        WIN.  Use PARAM2.
1B7  A5 B2
                STEP     STA   STEPNO        Save new Step No.
1B9  85 B7
                RUN      JMP   NXTSTP
1BB  4C 04 03
```

Program Module #3

| LOC | OBJECT | STEP | LABEL | COMMAND | PARAM1 | PARAM2 | PARAM3 |
|---|---|---|---|---|---|---|---|
| | | | | Command Decoder | | | |
| 00 | 00E00005 | Ø | DECODE | ALPIN | BUFFER | Ø | 5 |
| 04 | 06E0DF01 | 1 | | PACK | BUFFER | KEYVAL | 1 |
| 08 | 0BC80006 | 2 | | FILL | DISPLAY | Ø | 6 |
| 0C | 0ADCDF00 | 3 | | BRTABL | CMDTBL | KEYVAL | DECODE |
| | | | | Tipsy | | | |
| 10 | 0BC80006 | 4 | TIPSY | FILL | DISPLAY | Ø | 6 |
| 14 | 09130007 | 5 | PLUS | BRCHAR | GO | DECODE | READY |
| 1B | 08050000 | 6 | | BRANCH | PLUS | | |
| 1C | 0BE0FF06 | 7 | READY | FILL | BUFFER | FF | 6 |
| 20 | 07C2E004 | 8 | | UNPACK | TENTHS | BUFFER | 4 |
| 24 | 04E00005 | 9 | | HEXOUT | BUFFER | Ø | 5 |
| 28 | 05140B00 | A | | TIMER | 20. | BLANK | |
| 2C | 0BC80004 | B | BLANK | FILL | DISPLAY | Ø | 4 |
| 30 | 050A0D00 | C | | TIMER | 10. | ACCEPT | |
| 34 | 0BCC4002 | D | ACCEPT | FILL | DISPLAY+4 | DASH | 2 |
| 38 | 0BDB2001 | E | | FILL | CHAR | 20 | 1 |
| 3C | 0BC00004 | F | | FILL | THOUS | Ø | 4 |
| 40 | 02E60003 | 10 | | DECIN | GUESS | Ø | 3 |
| 44 | 0DE0E604 | 11 | | MATCH | BUFFER | GUESS | 4 |
| 48 | 08180000 | 12 | | BRANCH | NO | Ø | Ø |
| 4C | 0D52C101 | 13 | YES | MATCH | ZERO | TENS | 1 |
| 50 | 08180000 | 14 | | BRANCH | NO | Ø | Ø |
| 54 | 07C2E402 | 15 | | UNPACK | TENTHS | BUFFER+4 | 2 |
| 58 | 04E00405 | 16 | | DECOUT | BUFFER | 4 | 5 |
| 5C | 08050000 | 17 | | BRANCH | PLUS | | |
| 60 | 0BCC5302 | 18 | NO | FILL | DISPLAY+4 | "? | 2 |
| 64 | 08050000 | 19 | | BRANCH | PLUS | | |

TIPSY uses FILL, BRCHAR and BRANCH to clear the display and wait for the user to press GO to return to DECODE or any other key to start the test. READY uses FILL and UNPACK to generate a four digit decimal number from the system timer. HEXOUT and TIMER are used to display this number for two seconds. FILL and TIMER are then used to blank the display and wait for one second before accepting input. ACCEPT uses three FILL commands to: display two dashes as a signal that the user may give his input, clear any "premature" character that may have been input, and clear the system timer to be used as the ten second counter. The DECIN function is used to input the four digit guess. MATCH evaluates the guess and skips no steps if less than or greater than the actual value, where a BRANCH transfers control to NO. If the guess is correct, then one step is skipped and control goes to YES which uses another MATCH to determine if the amount of time taken to answer exceeded ten seconds. If less than ten seconds were used, then the time taken is displayed via UNPACK and DECOUT in tenths of a second. If the answer was wrong or took too long, then FILL is used to output two question marks to the display. Whether the answer was correct and in time or not, control returns to PLUS and another run can be started or control may be returned to DECODE.

Program Module #4

```
LOC OBJECT    STEP LABEL   COMMAND     PARAM1      PARAM2      PARAM3
                          Command Decoder
00  00E00005  Ø    DECODE  ALPIN       BUFFER      Ø           5
04  06E0DF01  1            PACK        BUFFER      KEYVAL      1
08  0BC80006  2            FILL        DISPLAY     Ø           6
0C  0ADCDF00  3            BRTABL      CMDTBL      KEYVAL      DECODE
                    Decimal/Hexidecimal Conversion
10  02E00500  4    DEC     DECIN       BUFFER      5           Ø
14  10E0E606  5            DECHEX      BUFFER      DATA        6
18  080F0000  6            BRANCH      OVRFLO
1C  07E6E006  7    SHOW    UNPACK      DATA        BUFFER      6
20  04E00005  8            HEXOUT      BUFFER      Ø           5
24  09130B04  9    WAIT    BRCHAR      GO          HEX         DEC
28  08090000  A            BRANCH      WAIT
2C  01E00500  B    HEX     HEXIN       BUFFER      5           Ø
30  11E0E606  C            HEXDEC      BUFFER      DATA        6
34  080F0000  D            BRANCH      OVRFLO
38  08070000  E            BRANCH      SHOW
3C  0BC85306  F    OVRFLO  FILL        DISPLAY     "?"         6
40  08090000  10           BRANCH      WAIT
```

DEC  Decimal to Hexidecimal Conversion
HEX  Hexidecimal to Decimal Conversion

DEC uses DECIN to input up to six digits in the shift mode, that is the digits enter from the rightmost digit position and are shifted left one position as each new digit is entered. The digit in the leftmost position is lost if another shift occurs. DECHEX is a special routine for doing most of the conversion work. It converts decimal values in BUFFER to hexidecimal values in DATA. The number of digits to be converted can be specified, and in this program is set to six. An overflow condition can not occur when converting from decimal to hexidecimal, but since the code for DECHEX and HEXDEC are basically identical and share most routines, the DECHEX has an overflow return = skip Ø steps. The only possible return from DECHEX is the normal return = skip 1 step. SHOW uses UNPACK and HEXOUT to convert the result to separate characters and output them to the display. WAIT uses BRCHAR and BRANCH to wait for the user to select HEX to decimal conversion by pressing GO or DEC to hexi-decimal conversion by pressing any other key.

HEX uses HEXIN to input up to six digits in the shift mode as in DEC above. The special routine HEXDEC does the conversion. Since a six digit HEX value may convert to a seven digit decimal value, the possibility of an overflow occurring is real. An overflow will cause the next sequential step to be executed, which is a BRANCH to OVRFLO. OVRFLO fills the display with question marks and returns to WAIT. If there is no overflow, then the decimal result is displayed by SHOW. The maximum HEX value that can be handled is F423F, which equals 999999 decimal.

Hexidecimal Conversion Subroutine

```
LOC   OBJECT     LABEL    OPERATION
130   A6 B2      HEXDEC   LDX  PARAM2    Get Pointer to Answer Buffer
132   A9 00               LDA  #Ø         Clear three bytes or six
134   95 00               STA  Ø,X        digit positions
136   95 01               STA  1,X
138   95 02               STA  2,X

13A   A6 B1      NEXT     LDX  PARAM1    Get Pointer to Input Buffer
13C   B5 00               LDA  Ø,X        Get next character
13E   30 0D               BMI  LZERO      Test leading blanks
140   A6 B2               LDX  PARAM2     Get Pointer to Answer Buffer
142   A0 11               LDY  #HEX       Test Hex to Dec or Dec To Hex
144   C4 B0               CPY  PARAMØ
146   F0 10               BEQ  HX         Hex to Dec
148   20 75 01            JSR  XTEN       Dec to Hex Subroutine
14B   B0 08               BCS  OVRFLO     Branch on Overflow
14D   E6 B1      LZERO    INC  PARAM1     Bump Pointer
14F   C6 B3               DEC  PARAM3     Decrement No. Digits
150   D0 E7               BNE  NEXT       Get Next
153   E6 B7               INC  STEPNO     Incr. Step No. for Normal
155   4C 04 03  OVRFLO    JMP  NXTSTP     or Next Step for Overflow

158   C9 0A      HX       CMP  #10.       Hex to Dec. Convert from
15A   30 02               BMI  OKAY       Hex Character to BCD byte
15C   69 05               ADC  #5
15E   20 70 01  OKAY     JSR  DSIXT      Hex to Dec Subroutine
161   B0 F2               BCS  OVRFLO     Branch on Overflow
163   90 E8               BCC  LZERO      Normal return
```

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

## Command Table Format

The Command Decoder uses a Command Table for its determination of which Step to go to as a function of the Program name typed in. Only the first two characters of a Program name are used. They are packed into a single byte and then used in a BRTABL Function. Each entry in the Command Table consists of two bytes: the packed character byte and the Step Number. For example, SCLOCK or Set Clock has an entry of D2 04, where the D2 is the packed representation of SC (S = D on keypad, C = 2) and 04 is the Step Number of the start of the SCLOCK Program. The Command Table is usually found starting at location A0 and is terminated by a ØØ byte.

## Function Table Format

The Interpreter looks up the absolute memory address of a Function in the Function Table. This consists of two bytes of address, low order then high order, for each function. The addresses are ordered by Function number, the first being ALPIN,..., the last MATCH. The basic Function Table starts at location 100. The Special Function Table follows the same rules but starts at location 120.

Hexadecimal Conversion Subroutine

- Continued -

```
LOC   OBJECT    LABEL     OPERATION
170   A0 10     DSIXT     LDY  #16.      Set Counter for 16 loops
172   F8                  SED            Set Decimal Mode
173   10 03               BPL  COMMON

175   A0 0A     XTEN      LDY  #10.      Set Counter for 10 loops
177   D8                  CLD            Set Binary Mode
178   85 D7     COMMON    STA  TEMP      Store New Value
17A   18                  CLC            Clear Carry
17B   A9 00               LDA  #Ø        Clear Temporary bytes
17D   95 03               STA  3,X
17F   95 04               STA  4,X
181   95 05               STA  5,X

183   B5 02     NTIMES    LDA  2,X       Shift old value by
185   75 05     LAST      ADC  5,X       adding to itself the
187   95 05               STA  5,X       required number of times
189   B5 01               LDA  1,X       16 for Hex
18B   75 04               ADC  4,X       10 for Decimal
18D   95 04               STA  4,X       Do addition for all three
18F   B5 00               LDA  Ø,X       bytes worth of data
191   75 03               ADC  3,X
193   95 03               STA  3,X
195   B0 1D               BCS  ERROR     Branch on Overflow
197   88                  DEY            Decrement Loop Counter
198   30 0E               BMI  DONE      When minus, then done
19A   D0 E7               BNE  NTIMES    If no zero, keep looping
19C   A9 00               LDA  #Ø        On zero, set up to add
19E   95 00               STA  Ø,X       in the new value by
1A0   95 01               STA  1,X       clearing the old values
1A2   95 02               STA  2,X       and then pick up the
1A4   A5 D7               LDA  TEMP      new value and make final
1A6   10 DD               BPL  LAST      loop.

1A8   B5 05     DONE      LDA  5,X       Move result from Temp
1AA   95 02               STA  2,X       to Result bytes
1AC   B5 04               LDA  4,X
1AE   95 01               STA  1,X
1B0   B5 03               LDA  3,X
1B2   95 00               STA  Ø,X
1B4   D8        ERROR     CLD            Clear Decimal Mode
1B5   60                  RTS            Return
```

Program Module #5

| LOC | OBJECT | STEP | LABEL | COMMAND | PARAM1 | PARAM2 | PARAM3 |
|---|---|---|---|---|---|---|---|
| | | | | Command Decoder | | | |
| 00 | 00E00005 | Ø | DECODE | ALPIN | BUFFER | Ø | 5 |
| 04 | 06E0DF01 | 1 | | PACK | BUFFER | KEYVAL | 1 |
| 08 | 0BC80006 | 2 | | FILL | DISPLAY | Ø | 6 |
| 0C | 0ADCDF00 | 3 | | BRTABL | CMDTBL | KEYVAL | DECODE |
| | | | | Add and Subtract | | | |
| 10 | 02E00500 | 4 | ADDSUB | DECIN | BUFFER | 5 | Ø |
| 14 | 06E0E603 | 5 | NEW | PACK | BUFFER | AREG | 3 |
| 18 | 02E00500 | 6 | NEXT | DECIN | BUFFER | 5 | Ø |
| 1C | 06E0E903 | 7 | | PACK | BUFFER | BREG | 3 |
| 20 | 0A5EDF05 | 8 | | BRTABL | ASTABL | KEYVAL | NEW |
| 24 | 10E6E9E6 | 9 | ADD | DECADD | AREG | BREG | AREG |
| 28 | 08120000 | A | | BRANCH | FLASH | | |
| 2C | 07E6E006 | B | SHOW | UNPACK | AREG | BUFFER | 6 |
| 30 | 04E00005 | C | | DECOUT | BUFFER | Ø | 5 |
| 34 | 09130006 | D | WAIT | BRCHAR | GO | DECODE | NEXT |
| 38 | 080D0000 | E | | BRANCH | WAIT | | |
| 3C | 11E6E9E6 | F | SUB | DECSUB | AREG | BREG | AREG |
| 40 | 08120000 | 10 | | BRANCH | FLASH | | |
| 44 | 080B0000 | 11 | | BRANCH | SHOW | | |
| 48 | 05021300 | 12 | FLASH | TIMER | 2 | BLANK | |
| 4C | 0BC80006 | 13 | BLANK | FILL | DISPLAY | Ø | 6 |
| 50 | 05021500 | 14 | | TIMER | 2 | WAIT2 | |
| 54 | 04E00005 | 15 | WAIT2 | DECOUT | BUFFER | Ø | 5 |
| 58 | 09130004 | 16 | | BRCHAR | GO | DECODE | ADDSUB |
| 5C | 08126000 | 17 | | BRANCH | FLASH | ASTABL | ASTABH |
| 60 | 1209110F | 18 | | "+" | ADD | "DA" | SUB |
| 64 | 00000000 | 19 | | 0 | | | |
| | | | | Reaction Time Tester | | | |
| 68 | 0913001C | 1A | REACT | BRCHAR | GO | DECODE | START |
| 6C | 081A0000 | 1B | | BRANCH | REACT | 00 | 00 |
| 70 | 0BC83F06 | 1C | START | FILL | DSPLAY | "Ø" | 6 |
| 74 | 0A9EC21D | 1D | TEST | BRTABL | TTABLE | TENTHS | TEST |
| 78 | 0BC80006 | 1E | HALT | FILL | DSPLAY | BLANK | 6 |
| 7C | 07C1E006 | 1F | | UNPACK | TENS | BUFFER | 6 |
| 80 | 06E0E603 | 20 | | PACK | BUFFER | AREG | 3 |
| 84 | 09130023 | 21 | WAIT | BRCHAR | GO | DECODE | STOP |
| 88 | 08210000 | 22 | | BRANCH | WAIT | | |
| 8C | 11C1E6E6 | 23 | STOP | DECSUB | TENS | AREG | AREG |
| 90 | 011E0000 | 24 | | 01 | HALT | Ø | Ø |
| 94 | 07E6E006 | 25 | | UNPACK | AREG | BUFFER | 6 |
| 98 | 04E00005 | 26 | | DECOUT | BUFFER | Ø | 5 |
| 9C | 081A9000 | 27 | | BRANCH | REACT | TTABLO | TTABHI |

ADDSUB Add and Subtract Decimal Numbers

ADDSUB permits a chained series of additions and/or subtractions to be made with up to six digit decimal numbers. One major restriction to be aware of: negative numbers and negative results are not permitted. ADDSUB uses DECIN to input the first decimal value in the shift mode, that is the current input digit appears in the rightmost display location and all previously input digits are shifted one position to the left with the leftmost digit being lost. The entire number may be erased by pressing the PC key. PACK converts the data from decimal characters to binary coded decimal BCD form two digits per byte. DECIN and PACK are then u used to input the second value. BRTABL determines whether the operation is to be an Add or Subtract as a function of the key used to terminate the decimal input. A + terminator will cause a branch to the ADD Step. A DA key will cause a branch to the SUB Step. Any other terminator will cause the current input value to replace the old total and thereby start a new chain operation. ADD uses a special function DECADD to add the contents of the old total AREG to the new input value BREG and stores the result in buffer AREG. If the total exceeds 999999., the capacity of the display, then the next Step is executed which causes a BRANCH to FLASH which flashes the last input value to indicate an overflow condition. If there is no overflow, then one Step is skipped and control goes to SHOW. SHOW uses UNPACK to convert from BCD form to separate characters. DECOUT then converts the decimal characters to displayable form and displays them. WAIT uses BRCHAR to wait for a GO to return to DECODE or any other key to go to NEXT. SUB is handled in an identical fashion except that the function DECSUB is called to process the subtraction operation, and instead of overflow, the error will occur on the total going negative. FLASH is just a combination of FILL, TIMER, DECOUT and BRCHAR/BRANCH. The only real tricky part of ADDSUB is the location of the ASTABL used by the BRTABL command at Step 8. Since the BRTABL function permits the table to be anywhere in memory, it requires a Page Zero pair of bytes to specify the start of the table. In ADDSUB this byte pair is tacked on to the end of the BRANCH function in Step 17. Since BRANCH does not use Param2 or Param3 this is permissible. The table itself is in the following Step and is terminated by the zero in the next following Step.

REACT Reaction Time Tester

REACT uses BRCHAR and BRANCH to wait until the user is ready to start a test. FILL is used to put Ø characters in all positions of the display. Step TEST uses BRTABL to wait until the system clock has a Ø1 in the TENTHS position, by using a table located as Step 24 which has as its only valid value an Ø1. When TENTHS equals Ø1, control goes to Step HALT. FILL clears the display. UNPACK and PACK combine to move the current value of the system clock TENS, TENTHS, and MILLI into buffer AREG, in effect saving the time at the start of the test. WAIT uses BRCHAR and BRANCH to loop until a key is pressed. GO returns to the command decoder and any other key stops the clock. The elapsed time is calculated by subtracting the start time from the current time via DECSUB. UNPACK and DECOUT display the reaction time accurate to the millisecond. BRANCH resets to the start of REACT. Since there can be no negative result from the DECSUB, there can be no possibility of executing Step 24, the table.

DECIMAL ADD and HEXIDECIMAL ADD

```
LOC   OBJECT     LABEL    OPERATION

130   F8         DECADD   SED          Set Decimal Mode
131   18         HEXADD   CLC          Entry for Hex Add
132   A0 03               LDY  #3      Service three bytes

134   A6 B1      NEXT     LDX  PARAM1  Get A buffer digit
136   B5 02               LDA  2,X
138   A6 B2               LDX  PARAM2  Add to B buffer digit
13A   75 02               ADC  2,X
13C   A6 B3               LDX  PARAM3  Store in C buffer
13E   95 02               STA  2,X
140   C6 B1               DEC  PARAM1  Decrement buffer pointers
142   C6 B2               DEC  PARAM2
144   C6 B3               DEC  PARAM3
146   88                  DEY          Decrement byte counter
147   D0 EB               BNE  NEXT    Continue if not zero
149   D8                  CLD          Clear Decimal Mode

14A   B0 02               BCS  RETURN  Test Carry
14C   E6 B7               INC  STEPNO  Skip one Step on Normal
14E   4C 04 03 RETURN     JMP  NXTSTP  Next Step on Overflow
```

DECIMAL SUBSTRACT and HEXIDECIMAL SUBSTRACT

```
LOC   OBJECT     LABEL    OPERATION

151   F8         DECSUB   SED          Set Decimal Mode
152   38         HEXSUB   SEC          Entry for Hex Subtract
153   A0 03               LDY  #3      Service three bytes

155   A6 B1      NEXT     LDX  PARAM1  Get A buffer digit
157   B5 02               LDA  2,X
159   A6 B2               LDX  PARAM2  Subtract B buffer digit
15B   F5 02               SBC  2,X
15D   A6 B3               LDX  PARAM3  Store in C buffer
15F   95 02               STA  2,X
161   C6 B1               DEC  PARAM1  Decrement buffer pointers
163   C6 B2               DEC  PARAM2
165   C6 B3               DEC  PARAM3
167   88                  DEY          Decrement byte counter
168   D0 EB               BNE  NEXT    Continue if not zero
16A   D8                  CLD          Clear Decimal Mode

16B   90 02               BCC  RETURN  Test Borrow
16D   E6 B7               INC  STEPNO  Skip one Step if no borrow
16F   4C 04 03 RETURN     JMP  NXTSTP  Next Step if borrow
```

HEX DUMP of Program Module #1

```
0000: 00 E0 00 05 06 E0 DF 01 0B C8 00 06 0A DC DF 00
0010: 02 E0 00 05 06 E0 C4 03 07 C4 E0 06 04 E0 00 05
0020: 09 13 00 04 08 06 00 00 02 E0 05 00 06 E0 C1 03
0030: 07 C1 E0 06 04 E0 00 05 09 13 00 0A 08 0C 00 00
0040: 11 D0 01 0A 09 13 00 13 08 10 00 00 12 CA 01 04
0050: 09 13 00 10 08 13 00 00 0B E0 00 06 07 C1 E0 04
0060: 02 E6 00 03 10 E6 E0 20 04 E0 00 05 05 02 1C 00
0070: 0B CC 00 02 05 01 1E 00 09 13 00 16 08 1A 00 00
0080: 04 E6 04 05 09 13 00 18 08 21 00 00 00 00 00 00
0090: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00A0: D2 04 32 06 DE 0A 3E 0C 30 16 9A 10 11 13 00 00
00B0: 11 D0 01 0A A0 00 00 11 40 00 90 1E 00 01 04 54
00C0: 02 55 82 04 12 18 53 09 00 00 00 00 00 00 C8 00
00D0: F0 03 E7 1F F0 03 D4 05 10 03 02 20 A0 00 15 11
00E0: 01 01 FF FF FF FF FF FF FF FF 04 04 00 00 00 89
00F0: 02 00 FF 02 09 FF 12 CA 00 00 80 17 17 04 00 01
0100: 04 00 34 04 00 34 04 00 34 34 04 00 34 04 00 34
0110: 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04
0120: 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00
0130: 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34
0140: 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04
0150: 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00
0160: 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34
0170: 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04
0180: 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00
0190: 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34
01A0: 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04
01B0: 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00
01C0: 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34
01D0: 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04
01E0: 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00
01F0: 34 04 00 34 04 00 34 04 D0 1E D0 1E D0 1E A8 17
0200: F8 A2 03 18 B5 C0 69 01 95 C0 90 2D E0 03 D0 26
0210: C6 C7 D0 22 18 B5 C3 69 01 C9 60 D0 07 A9 00 95
0220: C3 CA 10 F0 E0 01 D0 06 C9 24 D0 02 A9 00 95 C3
0230: A2 03 A9 0A 85 C7 CA 10 CA D8 60 A6 B1 B5 00 0A
0240: 0A 0A 0A 15 01 90 06 B5 01 10 02 A9 00 A6 B2 95
0250: 00 E6 B1 E6 B1 E6 B2 C6 B3 D0 E0 F0 32 A6 B1 B5
0260: 00 4A 4A 4A 4A A6 B2 95 00 E6 B2 C6 B3 F0 1E A6
0270: B1 A9 0F 35 00 A6 B2 95 00 E6 B2 E6 B1 C6 B3 D0
0280: DC F0 0C A2 D4 D0 02 A2 D2 20 83 03 20 A9 03 4C
0290: 04 03 A6 DB A9 20 85 DB E0 20 F0 F3 A5 B2 E4 B1
02A0: F0 02 A5 B3 10 5C A5 B1 10 58 A9 0A 85 BE A9 0A
02B0: 85 BF 20 D9 17 C6 BF D0 F9 C6 BE D0 F1 C6 B1 D0
02C0: E9 A5 B2 10 3D 20 83 03 A6 B2 A0 00 B5 00 38 D1
02D0: B4 F0 0E B0 0A A9 0D C5 B0 F0 04 E6 B7 E6 B7 10
02E0: 23 E8 C8 C4 B3 D0 E5 F0 F4 20 83 03 A5 B2 A4 B3
02F0: 88 91 B4 88 10 FB 30 0C 00 00 00 00 00 00 00 00
0300: A9 00 85 B7 20 D9 17 A5 B7 0A 0A 85 B8 A0 03 B1
0310: B8 99 B0 00 88 10 F8 E6 B7 0A 8D 20 03 EA EA 6C
0320: 00 01 00 00 00 00 00 00 00 A9 10 A2 D4 D0 08 A9
0330: 10 D0 02 A9 0A A2 D2 86 D6 85 D8 20 83 03 20 97
0340: 03 A5 B2 85 DA 10 03 20 D0 03 A6 D6 20 A9 03 20
0350: D9 17 A5 DB A2 20 86 DB C9 14 F0 B2 10 EC C5 D8
0360: 30 E5 85 DF 10 9E 20 8C 03 A6 B2 A0 00 B5 00 D1
0370: B4 F0 0A C8 C8 B1 B4 D0 F4 A5 B5 10 85 C6 B1 B4
0380: 10 F9 00 A5 B1 85 B4 A9 00 85 B5 60 A6 B1 B5 00
0390: 85 B4 B5 01 85 B5 60 A9 FF A2 06 86 D7 A4 B2 84
03A0: DA 20 D0 03 C6 D7 D0 F9 60 B5 00 85 D0 B5 01 85
03B0: D1 A4 B2 84 D7 B1 B4 10 04 A9 00 F0 03 A6 B1 D0
03C0: A4 D7 91 CE C4 B3 F0 27 30 03 86 10 E6 C6 10 E3
03D0: AA A4 B3 C4 B2 30 0A C4 DA 30 14 A4 DA E6 DA 10
03E0: 0C C8 B1 B4 88 91 B4 C8 C4 B2 30 F5 0A 91 E4 00
03F0: 77 7C 58 5E 79 71 76 30 38 54 5C 73 50 0D 70 0E
```

PLEASE Function Summary

| Code | Command | Param1 | Param2 | Param3 | Page |
|---|---|---|---|---|---|
| ØØ | ALPIN | Buffer | Start | End | 14 |
| Ø1 | HEXIN | Address | Display | Display | 14 |
| Ø2 | DECIN | Page Zero | Position | Position | 14 |
| Ø3 | ALPOUT | Buffer | Start | End | 20 |
| Ø4 | HEXOUT | Address | Display | Display | 20 |
| Ø4 | DECOUT | Page Zero | Position | Position | 20 |
| Ø5 | TIMER | Delay Time | Step Number | | 21 |
| Ø6 | PACK | Source | Destination | Number of | 22 |
| Ø7 | UNPACK | Buffer | Buffer | Bytes | 23 |
| | | Page Zero | Page Zero | | |
| Ø8 | BRANCH | Step Number | | | 24 |
| Ø9 | BRCHAR | Character to Match on | Step Number if Match | Step Number if Non-match | 24 |
| ØA | BRTABL | Table Address Indirect | Value Address Page Zero | Non-Match Step Number | 25 |
| ØB | FILL | Memory Address | Fill Value | Number of Bytes | 26 |
| ØC | COMPAR | First String | Second String | Number of | 26 |
| ØD | MATCH | Page Zero | Page Zero | Bytes in String | 26 |

Some Important Numbers

ØØAØ PLEASE Command Table - two bytes per entry
ØØBØ Current Command Function Number
ØØB1 Current Param1
ØØB2 Current Param2
ØØB3 Current Param3
ØØEF KIM - Program Counter - Low Order Byte
ØØFØ KIM - Program Counter - High Order Byte
ØØF1 KIM - Status Register
ØØF2 KIM - Stack Pointer
ØØF3 KIM - Accumulator
ØØF4 KIM - Y-Index Register
ØØF5 KIM - X-Index Register
Ø1ØØ PLEASE Standard Function Table
Ø12Ø PLEASE Special Functions Table
617/256-3649 Where to call if a real problem occurs.